FEB 18 1931

VOLUME 58 [W. B. No. 1032] NUMBER 11

MONTHLY WEATHER REVIEW

NOVEMBER, 1930

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UNITED STATES DEPARTMENT OF AGRICULTURE
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CORRECTIONS

Volume 57, September, 1929, page 362: Figure 1, in the lower left-hand corner the equation beginning "$1\frac{2}{cm}$" should be "1 cm ^{2}".

Volume 58, July, 1930, page 277: Table 1, insert heading "Southbound" in box head over date column. Same table, in line dated "Mar. 4–10," the entry in column 5 (76.4) should be "74.6"; line dated "May 27–June", in last column, "80.0" should be "81.1"; line dated "Oct. 15–21," third column from last, "91.1" should be "81.1"; line dated "Apr. 15–21," fourth and fifth columns, "67.8" and "77.6" should be "76.8" and "77.5," respectively.

MONTHLY WEATHER REVIEW

Editor, ALFRED J. HENRY

VOL. 58, No. 11
W. B. No. 1032

NOVEMBER, 1930

CLOSED JANUARY 3, 1931
ISSUED JANUARY 31, 1931

MEASUREMENTS OF VISIBILITY AT DANZIG

By Prof. Dr. H. KOSCHMIEDER

I. *Theoretical introduction.*—In the following discussion there is involved throughout the sighting distance of a black object in the daytime. By sighting distance we understand the greatest distance from the observer at which the object is still discernible.

The visibility, and hence the sighting distance, of a black object by day depends on conditions entirely different from those governing the visibility of a source of light at night. While at night the source of light appears duller and duller the farther it recedes from the observer, by day the black object appears lighter and lighter, within certain limits, the farther it is removed from him. At night there results a loss of light, by day an increase in light, with increasing distance to the source of light or to the black surface.

That by day there actually results an increase in light with increasing distance of the black object from the observer is immediately perceivable when on a hazy day one follows with the eye a receding train. At first it appears dark on the light background of the horizon and then, with increasing distance, lighter and lighter until it becomes as light as the horizon and hence becomes invisible. Another example: If there lie behind one another several similarly forested hills, then—with weather sufficiently hazy—to the unaided eye the second hill appears lighter than the first, the third lighter than the second, and so on. One then sees a whole series of steps in brightness [1] (1).

This increase in brightness of a black object by day with increasing distance of the object from the observer comes about through the diffuse scattering of light by the air and the disturbing particles contained in it. Let us consider a space of the pyramid of visual rays determined by the eye and the object. Into this there falls light from the sun, the sky, and the earth's surface. The air molecules contained in this space scatter light from these light sources in all directions according to Rayleigh's law of diffraction, while the larger disturbing particles, such as water droplets, dust particles, etc., do this through reflection, refraction and bending. Thus naturally there is scattered from the space under consideration a certain stream of light in the direction of the observer.

This stream of light A can be readily calculated. Let r be the distance of a volume element from the observer (fig. 1), and ω the angle of aperture under which the object appears, then the size of the volume element is given by $\omega r^2 dr$. The light stream scattered from a portion of space is proportional to the size of the space $\omega r^2 dr$ and the number of particles contained therein or, what amounts to the same thing, the turbidity of the air contained in the space. This we characterized by the coefficient of diffraction a. Thus the amount of scattered radiation becomes $C.a.\omega r^2 dr$, where C depends in complex manner on the incoming streams of light.

But only a part of this amount reaches the eye of the observer. In the first place this scattered radiation spreads out on a spherical surface so that there enters the factor r^{-2}, and in the second place the diffuse radiation is diffracted on the path to the observer so that there enters the factor e^{-ar} where, as above, a is the coefficient of diffraction. Therefore from a volume element that is found at the distance r from the observer there reaches the eye of the observer a stream of light

$$d\phi = e^{-ar} r^{-2} Ca\omega r^2 dr = \omega Cae^{-ar} dr$$

From a pyramid of visual rays with a length of l there is, therefore, scattered to the eye the light stream.

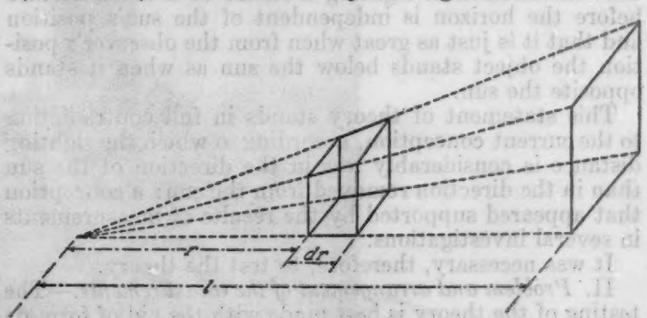

FIGURE 1.—Pyramid of visual rays

$$\phi = \omega \int_0^l aCe^{-ar} dr \tag{1}$$

The integration can be readily performed under the condition that a and C are independent of r. Hence all further consideration is limited to the following conditions

1. The direction of sight lies on the horizon and the turbidity of the air in the horizontal plane is constant.
2. The sky is cloudless, so that the same skylight prevails everywhere.
3. The surface of the earth is even and has everywhere the same albedo, so that the same *Unterlicht* prevails everywhere.

Then follows:

$$\frac{\phi}{\omega} = C\,(1 - e^{-al}) \tag{2}$$

wherein $\frac{\phi}{\omega}$ as the stream of light per unit angle has the dimension of a surface brightness. We call it briefly the air light (*Luftlicht*) of the pyramid of visual rays.

[1] In this connection F. Löhle (1) has devised a method of measuring the factor $1-e^{-al}$ appearing in Formula (4), and in his measurements at Potsdam has found good agreement between theory and observation.

If there stands at the distance l a black object with a surface brightness of 0 then $\frac{\phi}{\omega}$ produces an apparent surface brightness h_s of the black object, so that with $h_s=\frac{\phi}{\omega}$:

$$h_s=C\,(1-e^{-al}) \tag{3}$$

The constant C is determined from the simple consideration that h_s merges into the horizontal brightness h_h when the object is removed to infinity; so that

$$h_s=h_h\,(1-e^{-al}) \tag{4}$$

Hence h_s disappears for $l=0$, as, indeed, must be.

We take the last relation (4) as the air light formula.

Under the above-mentioned assumptions and with the air light formula there can be calculated the sighting distance (B)(3) for black, white, or colored objects. In the following we limit ourselves to black surfaces.

The sighting distance s_s of a black surface by day is determined immediately in that $l=S_s$ when $\frac{h_s-h_h}{h_h}=\epsilon$, where ϵ is the minimum relative difference in brightness that the eye can discern. For our problem ϵ is sufficiently constant and has the value of 0.02. Then

$$S_s=\frac{1}{a}\cdot ln\frac{1}{\epsilon} \tag{5}$$

Since the azimuth does not enter into (5) it results that the horizontal sighting distance of a black surface before the horizon is independent of the sun's position and that it is just as great when from the observer's position the object stands below the sun as when it stands opposite the sun.

This statement of theory stands in full contradiction to the current conception, according to which the sighting distance is considerably less in the direction of the sun than in the direction removed from the sun: a conception that appeared supported by the results of measurements in several investigations.

It was necessary, therefore, to test the theory.

II. *Problem and arrangement of the measurements.*—The testing of the theory is best made with the aid of formula (4), which shows that the quotient (6) $q=\frac{h_s}{h_h}$ is independent of azimuth. This is readily tested when we place on a circle (l=a constant) a sufficient number of black objects and measure h_s and h_h at each azimuth. Naturally, instead of several fixed objects we can use one object moving in a circle. In choosing the place of observation consideration is to be given that the above-named prerequisites are sufficiently fulfilled. This necessity can not be pointed out too emphatically. So long as it is not a matter of statistical observations, but one of the basic clarification of the statement of a question in the problems of meteorology, the correct choice of the place and time of observations is just as essential as the correct choice of methods of observation.

In order that the assumptions of theory may here be considered as fulfilled, the following are necessary:

1. Measurement must be made only with cloudless sky, since then the skylight is everywhere the same.

2. When snow lies on the ground measurement must be made over surfaces that are similarly covered with snow, since only then is the *Unterlicht* everywhere the same.

3. In the vicinity of the sun the object and the horizon must join, since otherwise the pyramid of visual rays toward the object and that toward the horizon will be at unequal distances from the sun, and since in the vicinity of the sun the brightness of the sky increases more than 10 per cent for 1° of approach to the sun.

4. In the vicinity of the coast measurement over the sea must be made only with onshore winds, since only then does the pyramid of visual rays lie with certainty within one and the same body of air.

5. In the vicinity of a large city the measurement must be made only to the windward of the city and then only when the pyramid of visual rays extending to the sighting lies outside the region of the city.

In view of these considerations the peninsula of Hela, jutting far into the Baltic Sea, was originally chosen as the place of observation. Unfortunately it had to be abandoned for political reasons. Since everything was prepared for observations at sea the first measurements necessarily took place from the east mole (Danzig). See 4 and 5 above. In order that conditions might be satisfactory the place of observation was later transferred 11 kilometers toward the interior and south of Danzig to Rostau, whereby southerly winds and the influences of a large city and of the coast were sufficiently eliminated.

In the measurements over the sea from the east mole (Danzig) the telephotometer, the range finder, and the theodolite were set up on the point of the mole. As an object there served a sail or material half black and half white (Figure 2), of which only the black surface having a size of 6 by 6 meters was measured. The sail was towed on a dredging boat on semicircles of 2 and 4 kilometer radius around the mole, and the position of the object was determined from time to time with the theodolite and the range finder (3 meter base).

In the measurements on land at Rostau there were set up 16 objects 1.35 by 1.35 meters on a circle with a radius of 1 kilometer.

The albedo of the objects was somewhat less than ½ per cent; the light reflected by the black surface was first noticeable at very great sighting distances.

The measurement of the apparent brightness h_s of the black object and the brightness of the horizon h_h was made with a telescope of 195 centimeters focal distance and an astrophotometer for surface photometry, the Apho 4 by Rosenberg of the Askania Works, Berlin—Freidenau, placed at my disposal as a loan.

III. *Results of the measurements* (4), (5).—1. East mole (*Ostmole*). The results of measurements for one day are given in Figures 3 and 4. Each value entered rests here on only one reading. The abscissa is the azimuth A, the ordinates are h_h (upper curve o) and h_s (lower curve +). Here the brightnesses are not reduced to equal distance from observer to object. However, the departures are very small and here unimportant.

The measurements give the result, surprising at first sight, that the brightness of the black object, when this stands in its own shadow ($A=0°$) amounts to several times (three to twelve times) the brightness under which the surface appears with full illumination ($A=180°$). This result, which had not been expected, is explained very simply by the theory of vision in that the apparent brightness of the black surface comes about through the air light; the horizontal brightness is the air light of an endlessly long pyramid of visual rays, so that the two thus change homologously. This can be plainly recognized from Figures 3 and 4.

The change in brightness of the black surface in these experiments was especially striking in that in addition to the black surface, as shown in Figure 2, there was

(To face p. 440)

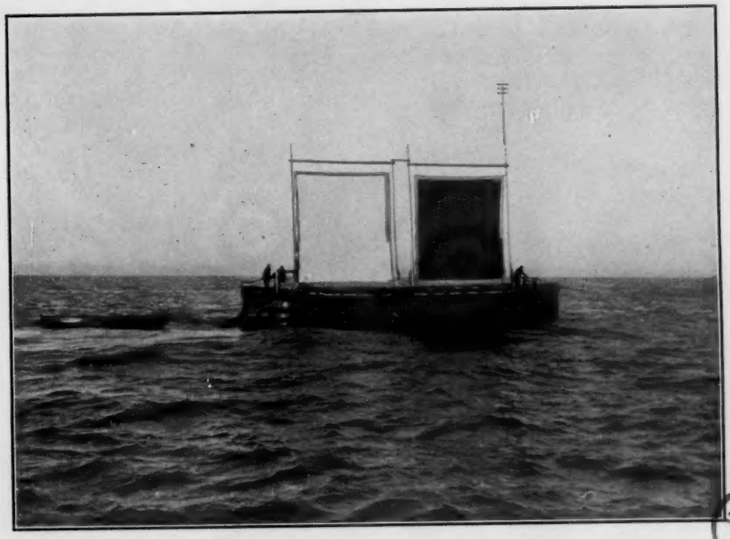

FIGURE 2.—Sighting objects on moving dredge boat

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also carried along a white surface. The black and the white surfaces were noticeably equally bright and differed in no manner one from the other when the boat carrying the object stood under the sun as seen from the observer and was sufficiently distant from the observer. Thereby the object ship was always plainly contrasted with the horizon. On the other hand one surface appeared deep black and the other glaring white when both stood opposite the sun as seen from the observer. From this fact it is shown very beautifully that the matter of the changes of brightness of the black surface is no academic bagatelle.

The next problem is to investigate whether the apparent brightness of the black surface is exactly proportional to the horizon brightness; that is, whether q possesses the same value in all directions. For this the values belonging to h_s and h_A must be evaluated. This was done with the aid of the smoothed curves $\bar{h}_s$, $\bar{h}_A$ drawn in Figures 3 and 4 for $A=0°$, $10°$, $20°$ . . . $180°$. Then there were formed the values $\frac{\bar{h}_s}{\bar{h}_A}$ and these were reduced to the same distance by aid of the air-light formula.

The q values so formed are by no means constant, as theory requires. They show, rather, both a time as well as an azimuthal dependence.

The time dependence of q is here (see fig. 5) very plainly decided. Both in the azimuths around 180° and in the azimuth 0° there results a plain decrease of q with change in time. The same holds for other azimuths. The q values at 180° and 0° lie nearly in a straight line. One can therefore look upon the line passing through the four points as the time change of q.

Just as plainly decided is the azimuthal dependence of q. In figure 6 the courses of the object are drawn as arcs with radii of 2 and 4 kilometers. The arrows give the direction of travel. In addition there is drawn q as radius vector out from the east mole, as is carried out for $A=0°$ and $A=180°$, and in the same direction which the pyramid of visual rays had at the moment of observation. In general, only the end of the vector is entered; its length for the azimuths, 0°, 10°, 20°, . . . 180° is marked by a circle or a double circle. The azimuths 0° and 180° show the highest values, those from 50° to 110° plainly the lowest values. The explanation of this azimuthal departure follows from the course of the object and the wind direction; offshore south-southeast winds on this day brought turbid air masses from land to sea. Through the deficiency in disturbing particles at sea the turbidity decreased more and more in the seaward direction. The least mean turbidity is thus to be expected in those pyramids of visual rays which lie at right angles to the coast, while the greatest mean turbidity may be expected in those pyramids of visual rays that lie parallel to the coast. In both cases there is agreement with observation.

In both semicircles this state of conditions is found very plainly, and since the air current on this day came unchangingly from the south-southeast, so in the double occurrence of azimuthal changes there can be seen a strong proof of the correctness of this conception. The azimuthal changes are thus explained by the assumption that with offshore wind the turbidity decreases seaward.

Summary of the results: The measurements at the east mole have brought the information that the brightness of the black surface changes identically with the brightness of the horizon and that below the sun it amounts to many times the brightness that is measured opposite the sun, and that the black surface at a proper distance from the observer and below the sun can be just as bright as a white surface with high albedo (70 per cent).

In addition the measurements show that with offshore winds over the sea and in the lee of a large city the air is not optically homogeneous.

(2) *Rostau, winter, circles.*—In order to avoid the influences of coast and a large city, as was mentioned, the place of observation was later removed toward the interior, to Rostau, 11 kilometers south of Danzig. In these measurements every emphasis was placed on the exact comprehension of the value q.

In all there were obtained 88 values of q which rest on 4 to 13, generally 5 to 7, photometric *focusings* over three complete circles and two semicircles on three days. The values are represented collectively in figure 7, as follows: For each semicircle, in one case after picking out a linear time course, there was formed a mean value q^m and then $q(A)/q^m$. The value qA/q^m was represented in polar coordinates with the azimuth A as amplitude and $q(A)/q$ as length. There was entered only the end of the vector, whose position is determined by the middle point of the small circle.

If the theory were entirely fulfilled all of the small circles would have to be placed on the large unit circle. As is seen this is very nearly the case. However, there remains a relatively large scattering. As a measure of the scattering we use, as ordinarily, the deviation

$$\Delta=\frac{q(A)-q^m}{q_m}\ 100$$

As a detailed investigation shows, the deviations can be looked upon as accidental; it is therefore admissible to combine the values into mean values. Then there results for the individual azimuth groups the following mean deviations:

TABLE 1.—*Rostau, January-February, 1929. Number of observations, 86*

	Azimuth					
	0°–10°	10°–30°	30°–50°	50°–110°	130°–170°	170°–180°
Observations	19	12	10	19	13	13
Mean deviation Δ, per cent	−1.5	−4.4	−2.8	−0.3	+6.3	+2.5
Mean error	±1.0	±3.0	±2.6	±1.9	±2.5	±1.6

The deviations are thus very small and exceed only in an unimportant way the mean error.

Summary of results: Despite the low elevation of the sun (<19°) and the high relative humidity ($f=60$ . . . 90 per cent) the mean deviations do not exceed 6 per cent. The difference $\Delta(180)-\Delta(0)$ amounts to only (4.0 ± 1.9) per cent.

In the winter measurements at Rostau we can, therefore, discover a good confirmation of the theory, at least for the short sighting distances occurring with these winter measurements. The result has so much the heavier weight since the elevations of the sun were small so that a plain difference would necessarily have appeared between q (180) and q (0) if such had generally been present.

3. *Rostau, summer, circles.*—The measurements were carried out in the summer of 1929 without important changes by my pupil, H. Rühle, at Rostau. In all 233 values were measured; these rest on nine readings on seven days.

The results are represented in Figure 8 in the same manner as for the winter measurements. There is noted again the large scattering. If we combine the values

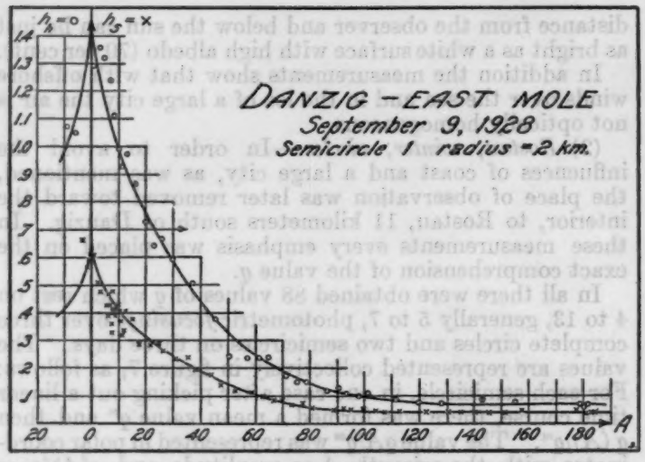

FIGURE 3.—September 9, 1928 (Danzig) east mole, semicircle 1 radius=2 kilometers

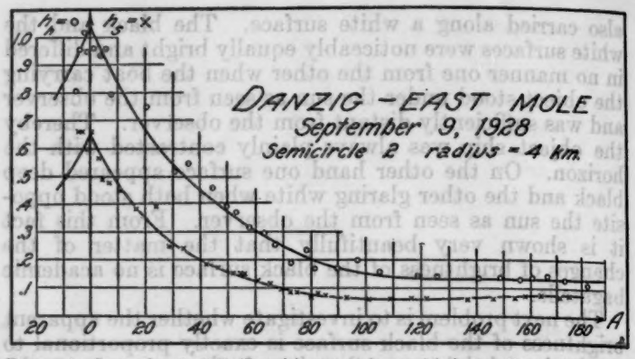

FIGURE 4.—September 9, 1928 (Danzig) east mole, semicircle 2 radius=4 kilometers

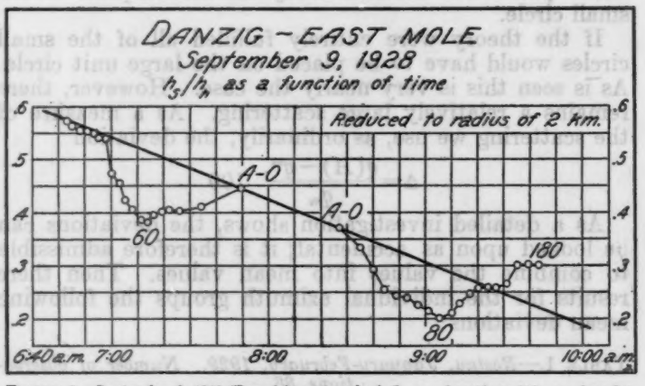

FIGURE 5.—September 9, 1928 (Danzig), east mole, h_s/h_h as a function of time reduced to radius of 2 kilometers

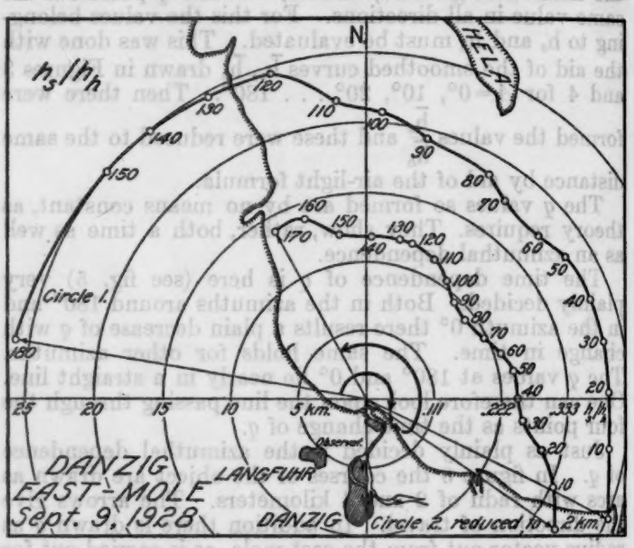

FIGURE 6.—September 9, 1928 (Danzig), east mole, Circle 1 and Circle 2 reduced to 2 kilometers

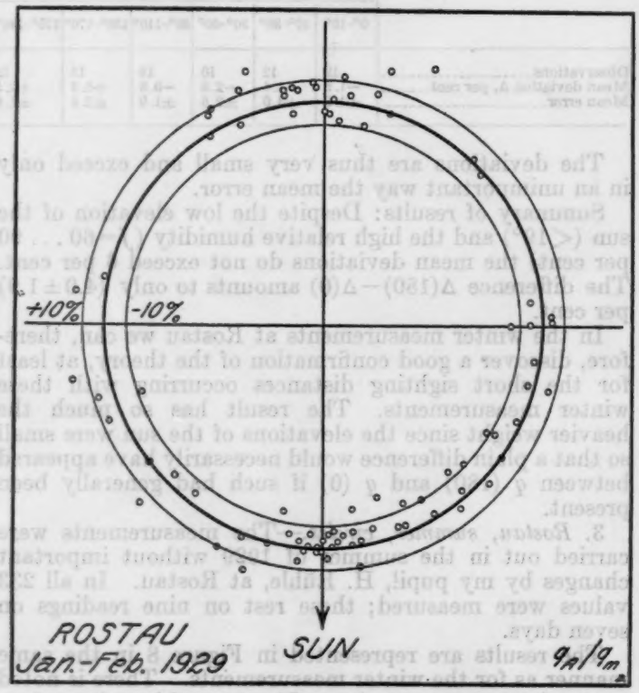

FIGURE 7.—Rostau, January–February, 1929, q^A/q_m

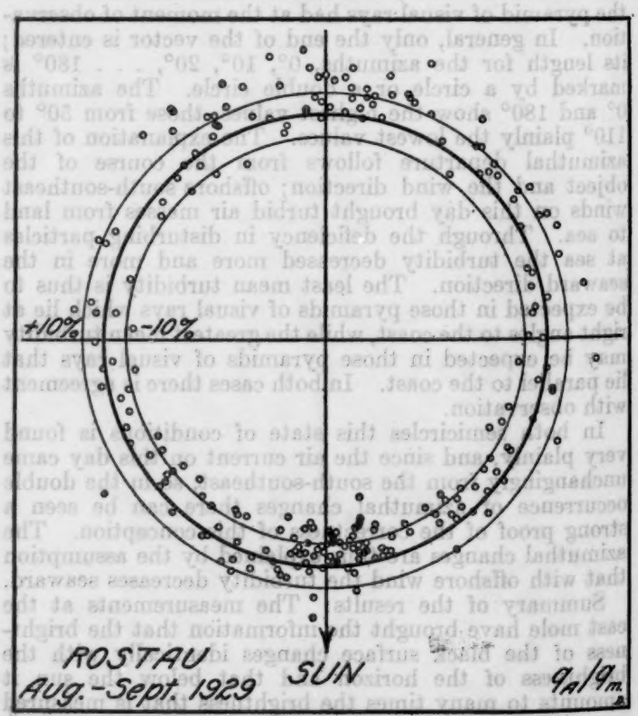

FIGURE 8.—Rostau, August–September, 1929, q^A/q_m—S./S.

into means according to azimuth groups there are obtained the following values:

$$\Delta = \frac{q(A) - q_m}{q_m} \cdot 100$$

in dependence on the azimuth A.

TABLE 2.—*Rostau, summer of 1929. Number of observations, 233*

	Azimuth						
	0°–10°	10°–30°	30°–60°	60°–90°	90°–120°	120°–150°	150°–180°
Observations	51	32	34	24	24	24	44
Mean deviation Δ, per cent	−5.0	−5.8	−4.5	−2.4	+3.0	+5.0	+9.7
Mean error	±1.2	±1.6	±1.3	±1.9	±1.8	±2.2	±1.4

Here there appears very plainly a dependence of the deviation on the azimuth A of the object in relation to the sun. The difference $\Delta(180) - \Delta(0)$ amounts to (14.7 ± 1.8) per cent and thus lies outside the limit of error. The cause of this finding, plainly departing from the winter conditions, evidently lies in the fact that the surfaces are not entirely black; the albedo does not have the value of zero. If the albedo amounts to only a few thousandths, then with sufficient illumination by the sun, especially with sufficiently low turbidity, it becomes noticeable throughout. The fact that the light reflected by the black surfaces increases with the intensity of illumination needs no discussion. The fact that with decreasing turbidity it has greater and greater importance has a two-fold reason: In the first place with low turbidity the air light is very small, so that the true surface brightness becomes decided relative to the apparent brightness, and in the second place the reflected light is diminished very little on the path from the object to the observer. The two influences combine, so that with decreasing turbidity (or increasing sighting distance) the influence of the albedo increases rapidly.

With this there agrees in the best manner possible the fact that on the days of measurement the sighting distance lay between 4 and 12 kilometers in winter and between 16 and 44 kilometers in summer, so that the influence of the albedo came into effect not in winter but, indeed, in summer. With this view there agrees further the sign of the deviation: Opposite the sun, where the surface is fully illuminated by the sun its true surface brightness is greater than below the sun where the surface stands in its own shadow. On the other hand the sign of the deviation is not consistent with the current idea that the sighting distance is greater opposite the sun than below the sun since then $\Delta(180 < 0$, $\Delta(0) > 0$ must be reversed.

Under reasonable assumptions the influence of the albedo, (inclusive of scattered light) can be calculated approximately and H. Rühle finds that the observed variation $\Delta(180) - \Delta(0)$ is of the same order as the calculated variation and decreases rapidly with increase in q, so that for $q = 0.08$ the variation relative to the calculations amounts to 20.8 per cent, while for $q = 0.226$ to only 6.3 per cent.

Summary of the results: The repetition of circle measurements in summer at great distances shows a plain dependence of the deviation Δ on the azimuth of the sun A.

It probably comes about that this azimuthal difference of Δ is a result of the reflective power, although small, of the black surface, since with great distances the air light decreases to the order of the reflected light.

4. *Rostau, auxiliary points.*—In order to strictly remove in a single case the influence of the albedo and of the scattered light, H. Rühle carried out four series of measurements.

In the azimuth and under the elevation of the fixed object as seen from the observer, there were set up auxiliary objects of the same low albedo, but at a lesser distance than the object—in furtherance of a method that F. Löhle had already proposed. The size of the auxiliary objects was so chosen that from the observer they appeared under the same angle as did the fixed object at a distance of 1,000 meters; thus in both cases the scattered light was the same in amount.

If h'_{s2}, h'_{s1}, and h'_h designate the brightnesses as read on the photometer for the object, the auxiliary object, and the horizon in the same azimuth; σ, the scattered light; and ζ the true surface brightness of the black surface (the reflected light); then there exist the following relations:

$$h'_{s1} = h_h \cdot q_1 + \sigma + \zeta \cdot e^{-al_1}$$
$$h'_{s2} = h_h \cdot q_2 + \sigma + \zeta \cdot e^{-al_2}$$
$$h'_h = h_h + \sigma$$

From these equations σ and ζ can be eliminated (this is the purpose of the measurement arrangement!) and there follows:

$$a = \frac{1}{l_2 - l_1} \cdot ln\left(1 + \frac{h^1_{s2} - h^1_{s1}}{h^1_h - h^1_{s2}}\right)$$

These measurements then furnished the following values of $\frac{a_{180} - a_0}{a_m}$. In the following table n indicates the number of individual a values, each of which rests on 13 photometric focusings, and s_s, the sighting distance calculated from the observed value of a.

TABLE 3.—*Rostau, southeast to southwest winds, cloudless sky*

Sighting distance in kilometers. s_s	Number of observations, n	$\frac{a_{180} - a_0}{a_m}$ (per cent)
33–17	32	+(10.2±2.4)
12	17	+(8.9±4.6)
8–13	10	+(5.3±4.3)
9–10	7	+(3.7±3.9)
3–5	23	+(2.2±2.9)

From this it is seen that with short sighting distances the deviations lie within the rather small limits of error. With great sighting distances the deviation plainly exceeds the limits of error. This result cannot be explained with the current conception that the sighting distance is greater opposite the sun than below the sun, since then the sign of the variation would have to be negative. The reason for this variation can be sought, then, only in nonhomogeneity of the air, which comes about in that with these great sighting distances the pyramid of visual rays is projected into the urban section of Danzig. That this explanation is correct proceeds from the fact that on a day with wind from the sea the sign was reversed for very great sighting distances.

TABLE 4.—*Rostau, northeast wind, cloudless sky*

Sighting distance in kilometers, s_s	Number of observations, n	$\frac{a_{180} - a_0}{a_m}$ (per cent)
>50	15	−(6.3±4.7)

On this day the decided northeast wind brought clean sea air into the measuring space on land. With advance over the land the sea air most certainly came to contain

more disturbing dust, so that the turbidity increased inland toward the southwest, while seaward, to the northeast, there was decrease. (A second example of this influence of the northeast wind is furnished by a disturbed day.) In the five cases above named the turbidity on the contrary, plainly increased northward toward the city.

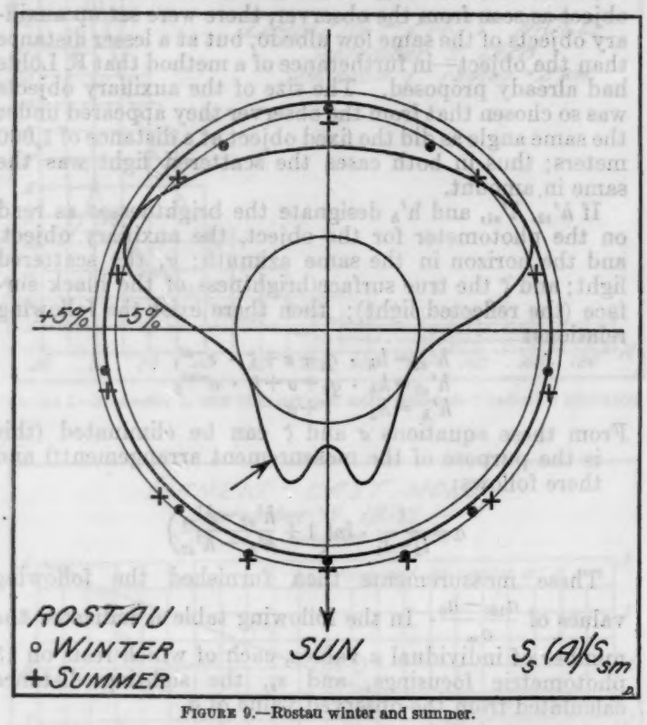

FIGURE 9.—Rostau winter and summer.

We may then state the matter thus: According to measurements in an atmosphere that is horizontally homogeneous the relation $q=\frac{h_2}{h_1}$ is independent of the azimuth of the direction of sight relative to the sun's vertical.

IV. *The sighting distances.*—In conclusion let us reckon the mean values of $\Delta(A)$ in relative sighting distances $\frac{s_s(A)}{s_{sm}}$ according to Tables 1 and 2 and plot the results in polar coordinates as earlier with those of $\frac{q(A)}{q_m}$ We then obtain Figure 9. In this there are entered for comparison the results obtained by another investigation, namely, the curve indicated by the arrowhead. It is perceived at first sight how slight are the deviations from theory now found in our Danzig measurements, even though in the values here used the influence of reflected light is not eliminated. The fact that the Danzig results so nearly approach theory has its basis first of all in the careful selection of the place of observation, one where nonhomogeneities of the air were especially avoided in the use of a strongly defined object, and in the application of the photometric process.

LITERATURE CITED

1. LÖHLE, F.
Meteorologische Zeitschrift, 1929, p. 49.
2. KOSCHMIEDER, H.
Beiträge zur Physik der freien Atmosphäre, XII, 1925, p. 33.
3. KOSCHMIEDER, H.
Beiträge zur Physik der freien Atmosphäre, XII, 1925, p. 171.
4. KOSCHMIEDER, H.
Danziger Sichtmessungen I, Forschungsarbeiten des Staatlichen Observatoriums, Danzig. Heft 2, 1930.
5. RÜHLE, H.
Danziger Sichtmessungen II, Forschungsarbeiten des Staatlichen Observatoriums, Danzig, Heft 3, 1930.

METEOROLOGICAL CONDITIONS ON THE SANTIAGO (CHILE)-BUENOS AIRES (ARGENTINA) AIRWAY

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[Translated from manuscript in French by W. W. Reed]

The increasing movement of international aerial traffic between the capitals of Chile and Argentina by airpost and passenger companies has made evident the importance of meteorological studies of the regions crossed by aviators in their transcontinental flights over South America.

To give greater clearness to our study we divide the route from Santiago to Buenos Aires into three well-defined sections: The central region of Chile, the Andean region, and the central region of Argentina; and shall endeavor to summarize their meteorological conditions separately.

CENTRAL CHILE

The meteorological characteristics of this section vary with the seasons.

In summer, stability and continuity of atmospheric conditions predominate. The region of the central valley of Chile is warmed by the rays of the sun, and the temperature rises to 86° F., or higher, in the shade, consequently the air undergoes expansion and the pressure is lowered.

This decrease in pressure brings about a difference in pressure relative to the ocean and causes a southwest wind, generally called "travesia, or cross-wind," which blows with greater force in the transverse valleys of the watercourses. The régime of this wind is simple: it begins near midday, acquires its maximum force between 2 p. m. and 4 p. m., and falls away toward sunset. During the night and the morning there is calm or the wind blows in light breezes from north or northwest.

The "travesia" is a surface wind. Aerological soundings show that its maximum intensity is observed to a height of 500 meters; toward 1,500 meters it falls away and there is a belt with variable wind or calm; then at about 2,000 meters and up to 3,000 meters, according to the season, there are found constant northwest winds. During the summer, cloudiness is a minimum in the interior of central Chile, and visibility is good; however, there generally forms along the coast a stretch of fog, 30 to 40 kilometers wide, and also stratus cloud, both of which dissipate toward noon.

In winter the meteorological conditions in central Chile change completely. The atmospheric régime is characterized by instability; scarcely does the anticyclonic régime set in with fine, cold weather and south wind when there appears a cyclonic régime with unsettled weather, north wind, and rain. These changes may be studied on our daily meteorological charts.

The upbuilding of an anticyclonic center leads to different consequences according to the position of the high pressure.

If the center of the high pressure is over Coquimbo or in the region of Aconcagua, the sky is generally covered with stratus, alto-stratus, cumulo-stratus, or alto-cumulus clouds. These different types appear in succession at different heights from 300 to 4,000 meters. Northwest winds predominate up to 5,000 or 6,000 meters, or are displaced by the normal currents from the west.

The second case is presented when the anticyclonic center has its barometric maximum over the ocean in the vicinity of the Juan Fernandez Islands; then west winds prevail and the weather is variable.

Lastly, the third case appears when the center of high pressure is found in the south; then the weather is set fair, with south wind and good visibility.

The coming of the cyclonic depression has different consequences according to the latitude of the center of low pressure. When it approaches from the northwest in the latitude of Coquimbo weather conditions change little in the central region of Chile; south winds prevail and high clouds, cirrus, cirro-stratus, and cirro-cumulus, partially cover the sky.

When the center of low pressure is shifted toward the Juan Fernandez Islands or comes directly from the west, the cloudiness is marked; the sky is covered with high stratus and nimbus, the wind blows from the north, and rain is possible.

Lastly, in the third case, when the center of low pressure passes south of the central section, foul weather is certain. At the surface there are strong north winds with rain; at 6,000 meters the winds are from northwest, and at 8,000 meters from the west. The layer of nimbus bringing the rain may lie between 300 and 2,000 meters, covering the mountains; above this layer of cloud there is generally another of high stratus of variable thickness. The sun shines between the latter thin clouds and those of the cirrus type.

In autumn and spring, meteorological régimes alternate; periods of stability are followed by the arrival of anticyclonic centers and cyclonic depressions. The period of rains generally extends from April to October.

From this summary of the meteorological studies of the central region of Chile there may be deduced some conclusions interesting in aviation: At the surface the prevailing winds blow from the southwest, and the landing fields should be oriented so that their major axes lie in that direction; the pilots can fly low and take advantage of the surface winds when going north, or they can fly high and make use of the higher currents when going south; then, too, an experienced pilot can fly through the bad weather of winter by taking advantage of the different cyclonic and anticyclonic currents, which change direction according to elevation, and by rising above the different cloud ceilings and fixing his course by astronomical navigation.

ANDEAN REGION

The region of the cordillera is, without doubt, the most difficult and the most dangerous for aerial navigation; and for this reason merited from the begining a special study, mainly through the installation of a private observatory at Caracoles, and, later, of a new observatory at Portillo at an elevation of 3,000 meters.

In order to cross the cordillera through the Pass of Uspallata the aviator must rise to a mean elevation of 5,000 meters. In this region there are peaks like Tupungato and Aconcagua with heights varying between 6,000 and 7,000 meters.

The diminution in atmospheric pressure produces different effects: (1) The density of the air being less, the power of the airplane is reduced to one-half or one-third, and the machine does not respond with the same precision as at the level of the central valley. This decrease can be calculated in percentage, taking into consideration the pressure, which is reduced from 10,333 kilograms per square meter at the level of the sea to less than 4,000 kilograms per square meter at these elevations. (2) The decrease in atmospheric pressure brings marked physiological effects upon the pilot and the passengers. If arterial pressure is not properly counteracted by atmospheric pressure hemorrhages may take place in the less resistant parts of the bodies of persons affected by hypertrophy or whose blood pressure is high (generally those of advanced age). At first the action of the heart is accelerated, then it is gradually lowered as a result of mountain sickness; respiratory action is accelerated, and, at length, the combined action of diminished pressure and cold, mainly in the time of snow and in an open plane, produces asthenia with all its consequences. Under such conditions the maintenance of will power to maneuver a plane becomes difficult.

After this brief comment on mountain sickness produced by abrupt variations in meteorological conditions, we proceed to the study of the atmospheric régime prevailing in the cordillera of the Andes.

Meteorological observations have been made for more than a year at the observatory of Caracoles, situated near the culminating point of the Pass of Uspallata at an elevation of 3,200 meters.[1]

The régime of the surface winds that blow in the massifs of the Andes is different from that found in the winds aloft, above 3,200 meters. While at this altitude prevailing winds come from the west during the entire year, on the other hand at Rio Blanco, Juncal, and Portillo there is observed every day, and especially in summer, a strong breeze from the west, which comes up about 10 a. m., reaches its maximum during the afternoon, and falls away at sunset. During the night the weather is generally calm. This regular régime of the winds is, of course, totally disarranged by storms.

Available statistical data permit the presentation of a general idea of the atmospheric conditions prevailing at these altitudes where observation and study have not been conducted in regular and methodical manner.

On account of the magnitude of the undertaking the crossing of the cordillera is not to be compared with the passage over the Pyrenees or over the Alps. Above its snowy summits there blow winds of such violence that they are able to impede the progress of the swiftest airplane, and it must not be forgotten that the power of the motors is reduced to less than one-half at these altitudes. In addition, the clouds covering the sides of the mountains and the snows hiding the ends of the craft from the pilot's view are important factors that must be taken into account in the aerial navigation of these regions.

During storms the different layers of cloud that form on the sides of the mountains group themselves between 1,000 and 5,000 meters; if an airplane from Mendoza bound for Santiago succeeds in rising above the clouds, the aviator will see the entire central region of Chile, from the cordillera to the sea, covered with a uniform

[1] The author's tabulation is omitted on account of the shortness of the record; a longer series of observations may modify the results considerably.

white blanket. The locating of landing fields under such conditions is a problem not yet solved.

The "air holes" that are observed in the cordillera may be of two classes: Those of thermal origin and those of dynamic origin.

The former are generally encountered in summer; the bases of the cordillera are warmed more than the snowy summits, and there results a difference in density which causes the aviator to lose elevation.

The latter are generally met with in winter, and are much more intense phenomena; the strong winds from north or west become engulfed in the deep valleys that separate the mountains and form violent whirls. The centrifugal force developed lowers the pressure in the center, diminishing the density of the air to such an extent as to cause the fall of the airplane.

These air holes occurring in the mountainous regions can be closely studied by means of soundings with equally inflated balloons and also by means of the statoscope.

In view of the fact that these dangerous zones are due to the topography of the region, it would be easy to make navigation charts in which there would be indicated, section by section, the meteorological conditions in the cordillera. In order to do this it is necessary to establish a systematic plan of aerial soundings, and to have well distributed observing stations in charge of an alert and competent personnel.

The conclusions from these studies are of inestimable value in aerial navigation. It is only with a complete knowledge of meteorological conditions in the cordillera of the Andes that pilots will be able to avoid the elements of nature and even to use them in increasing the safety of flights.

The cooperation of the different aviation companies with the Government of Chile and Argentina is necessary for the undertaking of the studies on the two sides of the Andes.

CENTRAL REGION OF ARGENTINA

This region presents meteorological characteristics entirely different from those noted in the central region of Chile. Rains and storms occur in any and all periods of the year, but more generally in summer, and the development followed in the meteorological phenomena is very different.

Generally after two or three days of marked warmth in central Argentina, the air expands and the pressure lowers, forming a decided continental depression of thermal origin, whose center is frequently situated between Mendoza, San Juan, and Cordoba.

If, under these conditions, an anticyclonic center moving from southern Chile penetrates Argentina through Neuquen, and advances along the Atlantic coast, there is produced a strong barometric gradient between the area of high pressure (polar) and the area of low pressure (equatorial).

This difference in pressure, intensified by the advance of anticyclonic air toward the stationary depression, gives rise to a violent southeast[2] wind, the "pampero," or wind of the pampa, a surface wind which may be avoided by flying at a great height.

The cold air of the polar front, more dense and consequently heavier, penetrates like a wedge under the warm, less dense, and therefore lighter, air of the continental depression. The latter is forced to rise and there are formed violent convectional currents, which are cooled on rising into higher regions. This cooling lowers the point of saturation and the water vapor condenses into clouds, of which the predominant form is cumulo-nimbus, very dangerous in aviation. Lightning, thunder, and heavy downpours or hail, accompany the pampero.

The depression takes a V form and moves obliquely toward the Atlantic coast; the line of discontinuity is, in this case, well marked. The storm conditions can recur during warm hours on several successive days at different points in the direction of advance.

During winter atmospheric conditions in the central region of Argentina are usually more stable.

From this brief analysis of meteorological conditions in central Argentina, it appears that in any period of the year, and especially in summer, air pilots may be exposed to accidents of meteorological origin, both through the drift caused by the strong winds, the "pampero" and the "zonda," and through the strong convection currents developing during storms. The danger of fire from continuous electrical discharges in the stormy regions is problematical.

With a complete knowledge of meteorological conditions in the regions over which flight is made, all of these phenomena can be avoided and the safety of the course increased.

CONCLUSIONS

From this study it develops that the three sections found along the route from Santiago to Buenos Aires have characteristics meteorologically different, and that for the development of regular flights it is necessary to have a good meteorological service to the end that pilots, at any time whatever, may be informed in a general way of atmospheric conditions along their routes. This, with the indispensable knowledge that every pilot must possess, will contribute effectively to the reduction of accidents in aviation.

At each aviation base along the route there should be a meteorological station with its radio-telegraphic station in order that there may be uninterrupted communication with the other stations along the route.

It is very necessary to bring about international cooperation between the meteorological services of Chile and Argentina, and, especially, to get assistance from the aviation companies profiting most directly from these services.

Another very important matter is the transmission of meteorograms by the different South American stations at fixed hours, to the end that the formation and development of the different meteorological phenomena may be followed daily, and their advances over the continent foreseen.

[2] It may be that the author inadvertantly used the word "sud-est" where "sud-ouest" was intended.—*Ed.*

RECENT WARM-WEATHER TRENDS AS SHOWN BY GRAPHS OF ACCUMULATED TEMPERATURE

By W. A. MATTICE

[Weather Bureau, Washington, D. C. May 23, 1930]

Has the country been experiencing a series of abnormally warm years? We hear many suggestions concerning this, among them the ones from the "old-timers" who continually say that the weather isn't like it was when they were young. Here in Washington, for instance, we continually hear that skating formerly lasted from December to March—on the Potomac River too! Also, not so long ago, there was a cartoon in a local paper showing a freight train being run over the ice! It is a common experience of Weather Bureau officials at nearly every station that people are continually talking about the "good old days" when snow lay on the ground much longer than it does now, or skating lasted longer, or the winters are mild compared with those "when we were young," and the summers are also becoming either warmer or cooler, etc. These are common observations throughout the country, and at present there is much comment that the past few years have been abnormally warm, especially the winters.

This interest in the matter of possible recent abnormal trends in seasonal weather prompted a study of the temperature conditions for the past 10 years in comparison with the normal, by seasons, and for several representative sections of the country.

Instrumental measurements of the weather by trained observers are naturally highly accurate, compared with our personal reaction to small changes in temperature, pressure, humidity, etc. For example, we may experience weather which feels abnormally cool when the daily mean temperatures are very close to normal. This is not uncommon, for our reaction to the weather depends not only on our physical condition at the time, but also on our impression of what the weather should be. Our mental hazards are as real in connection with the weather as they are on the golf links.

There are several ways of comparing temperatures in one place with those in another. We can use departures from normals for various periods, the extremes, extreme range, etc., but for our present purpose it seems best to use the accumulated departures from normal of weekly mean temperatures. This method of comparison is preferable because it affords a very graphic picture of what has really happened. We can remember easily long spells of hot weather in spring or summer, or protracted severe weather in winter, and the accumulated departure method of charting abnormalities presents these in their true proportion. These accumulated experiences are deeply impressed on our minds just as their imprint stands out on the graph of accumulated departures. Again, a long period of moderately warm or cold weather usually makes only a fleeting personal impression; but small deviations from normal, when long sustained, are of much importance and they show up also in proper proportion on the accumulated departure graph.

For a country as large as the United States any small number of stations would hardly be representative of general weather conditions; in fact, the some 200 first-order Weather Bureau stations are considered inadequate in some respects. However, we selected for this study six stations disposed in a fairly straight line across the country and representing weather types for rather typical sections, as follows: Washington to represent the Atlantic type; Cincinnati, the Ohio Valley type; Kansas City, the Plains type; Denver, the Rocky Mountain type; Salt Lake City, the Great Basin type; and Sacramento, the Great Valley of California type. These stations all lie close to the fortieth parallel and represent typical

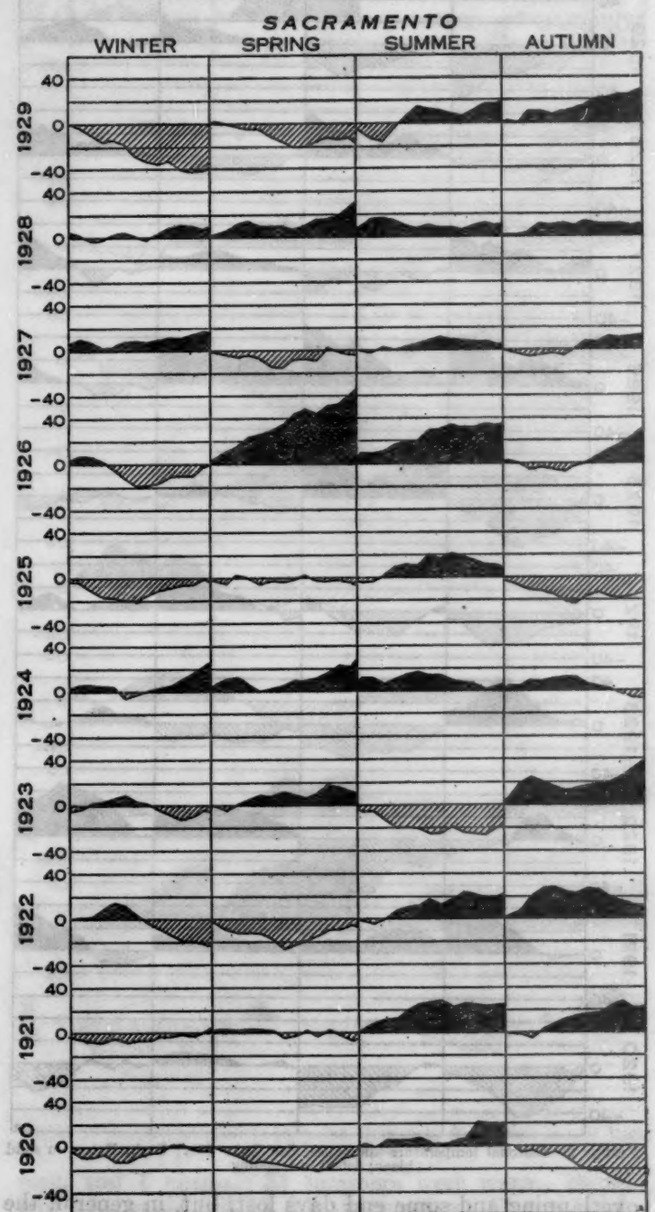

FIGURE 1.—Seasonal temperature anomalies, Sacramento, Calif.; excess in solid black; deficit in hatching

areas that are geographically comparable, but are not, of course, representative of weather conditions for the entire country.

The graphs are based on departures from normal of the weekly mean temperatures, as published in the Weekly Weather and Crop Bulletin. The graphs represent

accumulated values from week to week from the beginning of the respective seasons; that is, beginning with the first week, its departure is entered and the succeeding weeks' departures are added algebraically. Each season is entered separately, the yearly period of 52 weeks being arbitrarily divided into seasons of 13 weeks each. Thus, the winter season covers the approximate period from December 1 to February 28. There is, of course, some

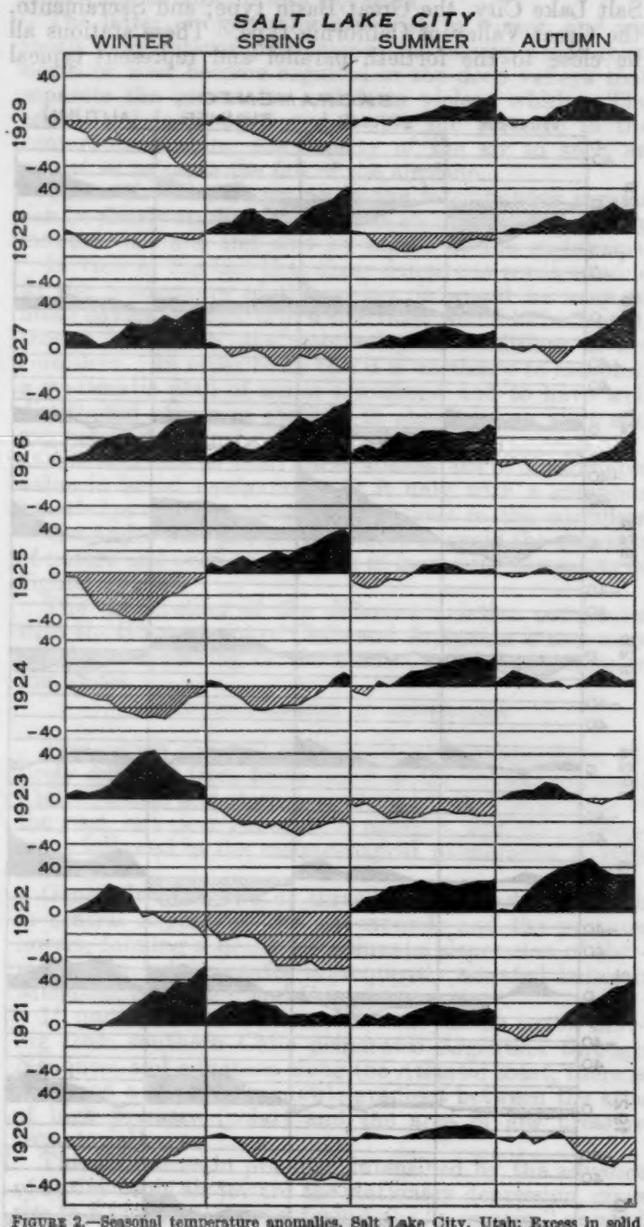

FIGURE 2.—Seasonal temperature anomalies, Salt Lake City, Utah; Excess in solid black; deficit in hatching

overlapping and some end days lost, but, in general, the seasons are strictly comparable.

Reference to the Washington graph shows that 8 of the past 10 winters were warm, 1 was cool, and 1 nearly normal. For the spring, 8 were warm, and 2 cool; the summers were evenly divided, 5 being warm and 5 cool. The autumns were nearly all warm, 9 being above normal, with only 1 below. Thus, we can say, as far as Washington is representative of the Atlantic coast, that the past 10 years have been warm, especially the winters and autumns. In the aggregate there are 40 seasons shown on this graph, 4 for each of the 10 years; of these 30 have been warm, 9 cool, and 1 about normal.

At Cincinnati conditions as to warmth were not so marked as at Washington. Here 6 winters were warm and 3 cool, with 1 normal; the springs were evenly divided, as were the summers. The autumns were divided 7

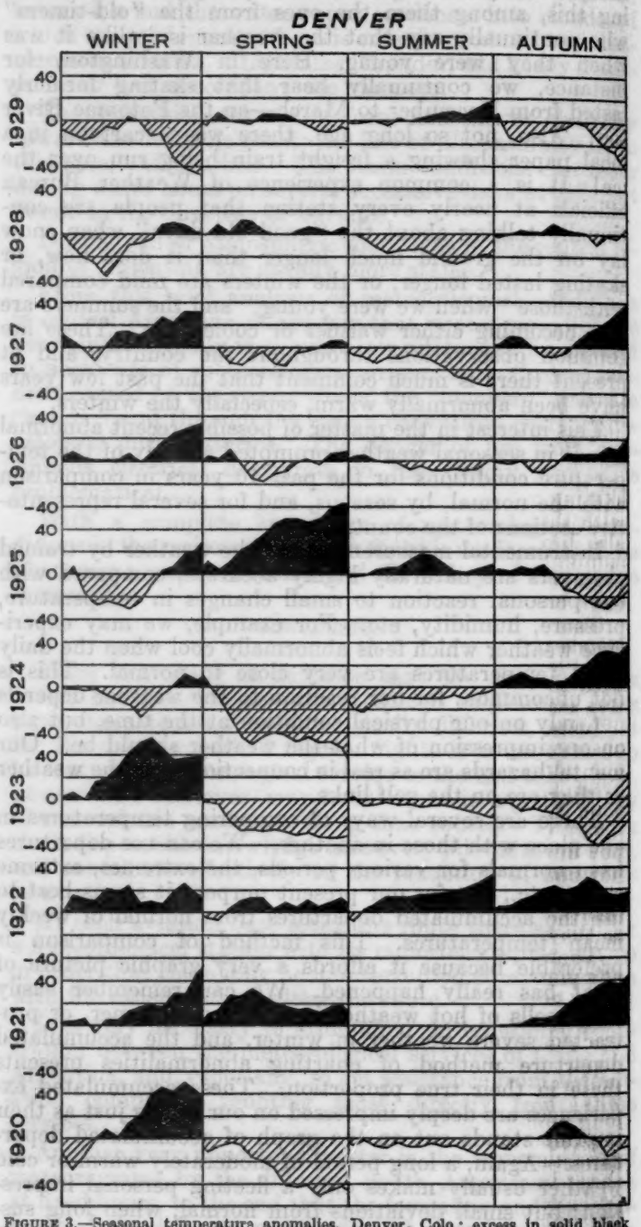

FIGURE 3.—Seasonal temperature anomalies, Denver, Colo.; excess in solid black deficit in hatching

warm and 3 cool, and a summary of the totals shows 23 seasons warm, 16 cool, and 1 normal.

At Kansas City 6 winters were warm and 4 cool; 6 springs were warm and 4 cool; 4 summers were warm and 6 cool, while 6 autumns were warm, 2 cool, and 2 normal. In the aggregate 22 seasons were warm, 16 cool, and 2 normal.

At Denver 6 winters were warm and 4 cool; 4 springs were warm and 6 cool; 3 summers were warm and 7 cool;

6 autumns were warm and 3 cool, with 1 normal. Thus, at Denver, there were 19 seasons warm, 20 cool, and 1 normal, making the totals nearly equal for the period.

At Salt Lake City the winters were evenly divided; 4 springs were warm and 6 cool; 7 summers were warm and 2 cool, with 1 normal, while 7 autumns were warm, 2 cool, and 1 normal. Here the totals swing back toward the

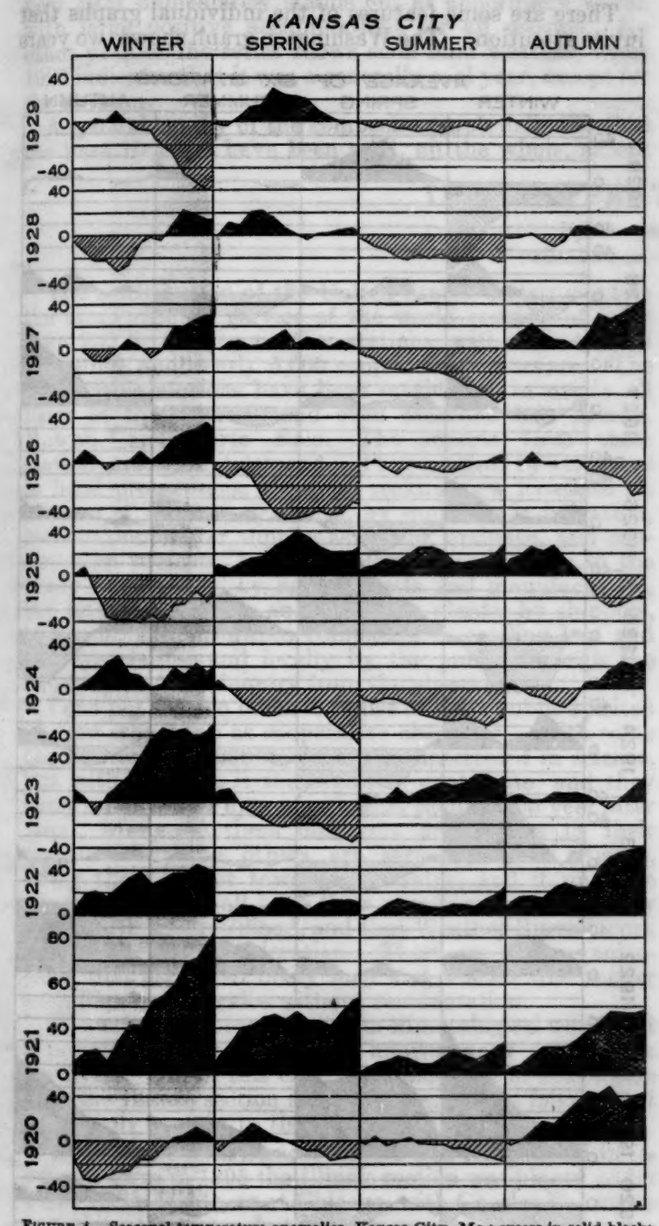

FIGURE 4.—Seasonal temperature anomalies, Kansas City, Mo.; excess in solid black; deficit in hatching

tendency in the east, with 23 seasons warm, 15 cool, and 2 normal.

At Sacramento 3 winters were warm, 6 cool, and 1 normal; 4 springs were warm, 5 cool, and 1 normal; 9 summers were warm, 1 cool; 8 autumns were warm and 2 cool. Thus, at Sacramento the summers and autumns have been consistently warm and the winters and springs relatively cool. The totals show 24 seasons warm, 14 cool, and 2 normal.

Grouping the graphs and taking the combined number of stations and seasons, 240 in all, there were 141 seasons warm, 90 cool, and 9 with about normal temperatures. Thus, considering the entire country as represented by these areas, the past 10 years have been decidedly warmer than normal. Considered by seasons, we find 34 winters warm, 23 cool, and 3 normal; 31 springs were warm, 28

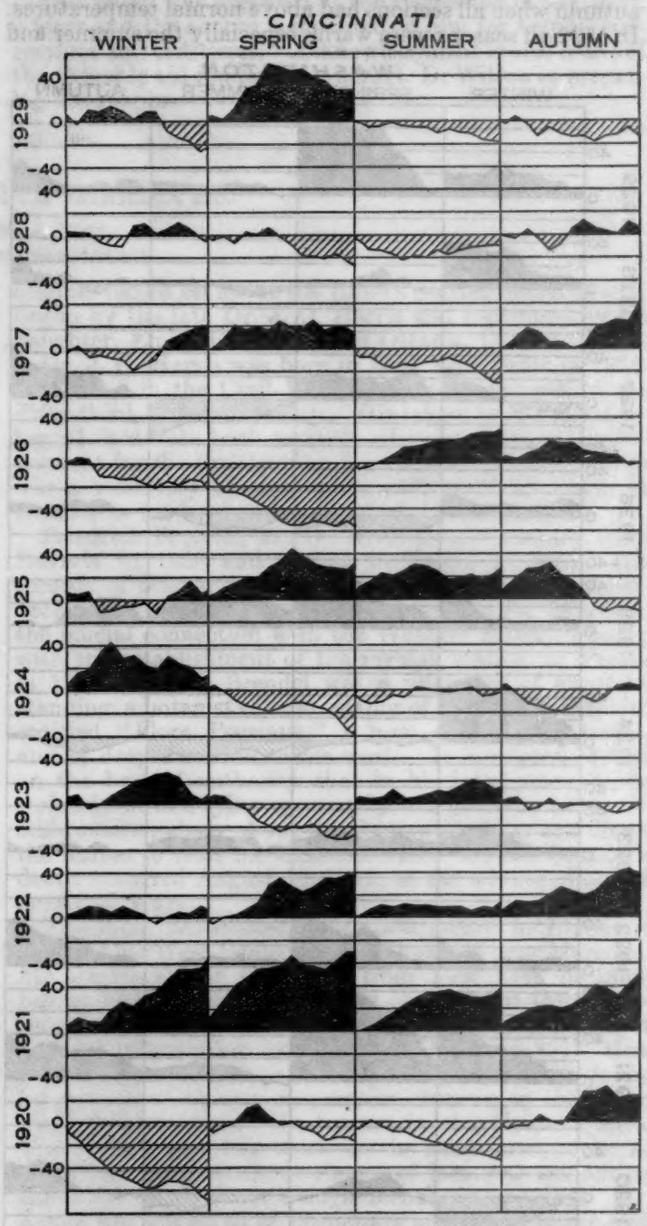

FIGURE 5.—Seasonal temperature anomalies, Cincinnati, Ohio; excess in solid black; deficit in hatching

cool, and 1 normal; 33 summers were warm, 26 cool, and 1 normal; and 43 falls were warm, 13 cool, and 4 normal.

Summarizing more generally we find that during the last 10 years the winters in the eastern half of the United States have been warm, with 7 above normal, 1 below, and 2 average. In the western half they were evenly divided. The springs were slightly warmer in the east, 6 being warm and 4 cool, while conditions were just

reversed in the west. Four summers were warm and 6 cool in the east, while in the west 8 were warm and 2 cool. The autumns were equally and markedly warm in both sections, each showing 8 warm and 2 cool.

If we consider the individual years we find that in 1920 the winter, spring, and summer were cool, but the autumn warm. In 1921 all seasons were warm, especially the autumn when all sections had above normal temperatures. In 1922 all seasons were warm, especially the summer and

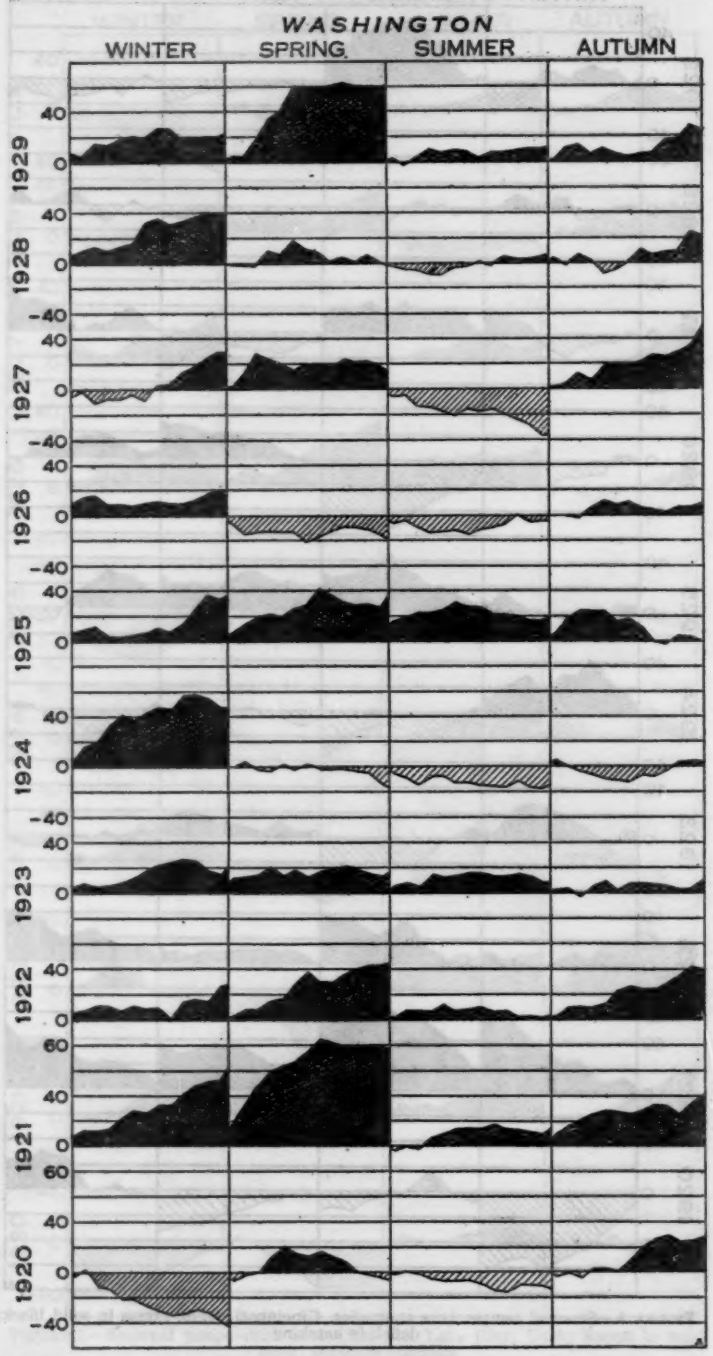

FIGURE 6.—Seasonal temperature anomalies, Washington, D. C.; excess in solid black; deficit in hatching

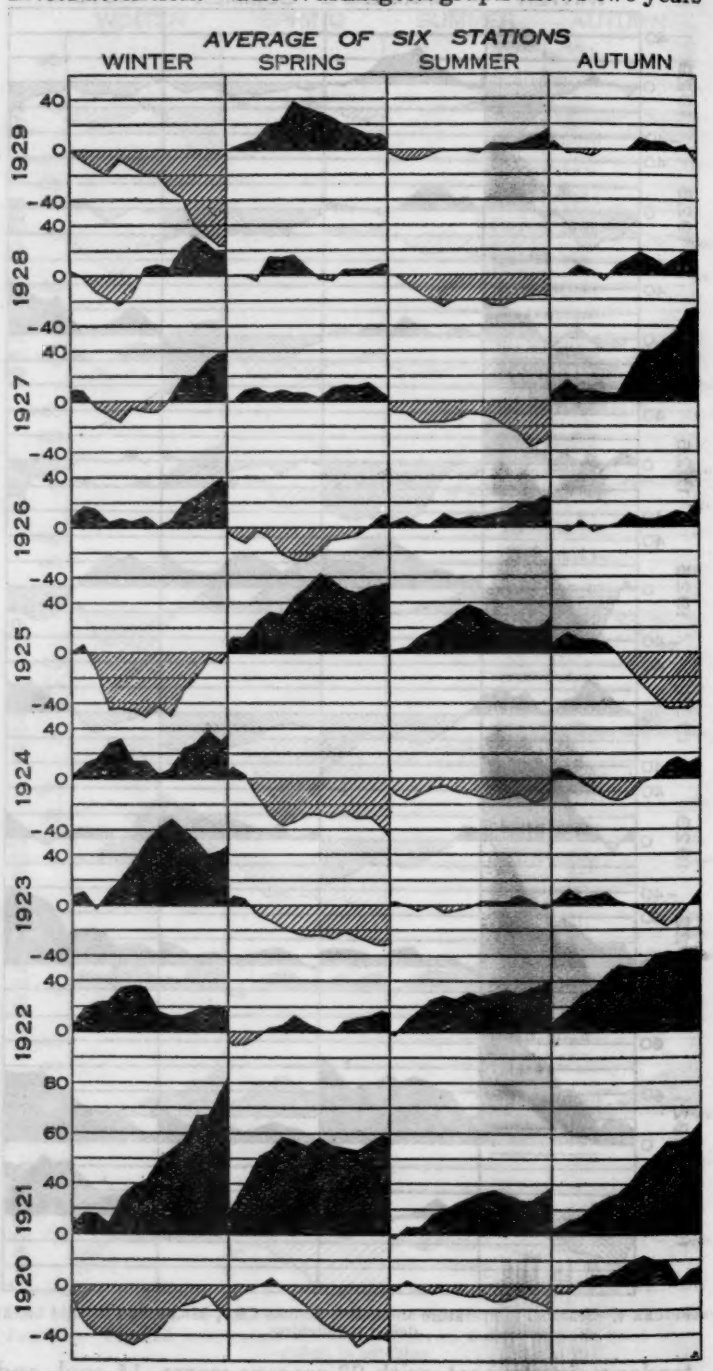

FIGURE 7.—Average of the six stations for years 1920–1929.

autumn, with all sections above normal. In 1923 the winter was warm, the spring cool, the summer evenly divided between east and west, and the autumn warm. In 1924 the winter was warm, the spring cool, the summer cool, and the autumn warm. In 1925 the winter was cool and the spring and summer warm, while the autumn was slightly cool. In 1926 the winter was warm, the spring cool, the summer evenly divided, while the autumn was warm. In 1927 the winter was warm, the spring evenly divided, the summer cool, and the autumn warm, with all sections above normal. In 1928 the winter was evenly divided, the spring was warm, the summer was cool, while the autumn was warm. In 1929 the winter was cool, the spring evenly divided the summer warm, and the autumn evenly divided.

There are some features of the individual graphs that invite attention. The Washington graph shows two years of abnormally high temperatures in winter and spring, 1921 and 1929, the accumulated departures for 1921 being especially marked when at one time there was an accumulation of about 150°. The Cincinnati graph also shows this abnormal condition in the two years, but 1929 is not so marked as in the Washington graph. The winter of 1921 in Kansas City is especially noteworthy, as the accumulation at the end of the winter was over 120° above

average, while the combined winter and spring accumulations reach over 180°. The graphs for the other stations, however, present no such marked accumulations.

The composite graph for all stations shows several interesting features. It will be noted that the range of temperatures on this graph has been increased to twice that on the others in order to give greater detail. The year 1921 immediately stands out as abnormally warm, with large positive accumulations for all seasons. No other year of the series shows such mild weather, while 1920 indicates that it was a generally cool year, except for the autumn.

A general survey of the composite graph indicates that the past 10 years have been mild, on the whole, except 1920, and, with the exception of 1929 and 1925, the winters have also been rather mild. Springs also show a tendency toward mildness, while summers apparently are close to normal. Autumns are also mild, especially 1921, 1922, and 1927. It would seem, therefore, that the claim that the past 10 years have been rather mild is substantiated by the evidence presented.

This paper was prepared at the suggestion of Mr. J. B. Kincer and the author is indebted to him for helpful suggestions and criticisms. Acknowledgment is also made of the valuable aid rendered by Mr. H. D. Wilson in preparing the graphs.

THE COOPERATIVE OBSERVER[1]

By CLARENCE J. ROOT

[Weather Bureau Office, Springfield, Ill.]

The contribution of the United States Government to the climatological service of the world consists of more than 200 first-order weather stations, with their trained personnel, and nearly 5,000 cooperative observers. The cooperative stations have been established in nearly all parts of the country, and even extended into Alaska, Hawaii, and Porto Rico. The reports from these stations are in great demand. They are used by attorneys in legal proceedings, by those seeking new locations on account of business or health, by engineers in irrigation, reclamation, water supply, sewerage, drainage, and construction projects, by meteorologists, and others in the study of climates, by agriculturists and manufacturers, the latter in locating and operating plants, by shippers, railroads, and insurance companies in settling loss and damage claims, and locally by the public through the newspapers or by inquiry from the observer.

I can not say too much in praise of these public-spirited citizens who serve as cooperative observers. With some the weather is a hobby, others are interested in science, but with many it is the desire to contribute, and they carry on day after day, month after month, and year after year. Many of these observers are leaders in their communities; the others are serious-minded citizens, doing their bit for town and country, and it must be remembered that all have their vocations by which they are furnished a livelihood, and that Weather Bureau work is a secondary consideration. There are few organizations that secure so many men and women who render such high-class service without remuneration.

The writer has been engaged in climatological work over a period of 24 years and has known many cooperative observers. All of this experience has been in connection with the Illinois section and the remarks that follow must necessarily pertain to the service in Illinois.

When the climatological service was reorganized in its present form in 1895 the Illinois section was placed under Prof. Willis L. Moore at Chicago, with Charles E. Linney as assistant director, but in a few months Mr. Linney was made director. Prior to 1895 the work had been handled at Springfield by Col. Charles F. Mills, a State official, and John Craig, Government observer. In 1899 Mr. Linney brought the service back to Springfield and in 1900 he was succeeded by Montello E. Blystone. William G. Burns relieved Mr. Blystone January 1, 1903, and Mr. Burns turned the work over to the present section director in 1911.

In discussing personnel mention should be made of some of the old-time observers. The oldest continuous original record on file at the Illinois Section center is that begun by the late Dr. J. O. Harris and continued by his daughter, Emily H. Merwin, of Ottawa, Ill.

Dr. J. O. Harris was born in New York State in 1828. He served in the Civil War as assistant surgeon of the Fifty-third Illinois Infantry. His labors in the meteorological field date back to 1853, when he acted as correspondent for the Smithsonian Institution. Doctor Harris was a voluntary observer from 1870 until his death at Ottawa in 1905, when his daughter succeeded him.

Friedrich Brendel, M. D., came to this country from Bavaria in 1850 and settled in Peoria in 1852. His records of temperature and rainfall began in December, 1855, and continued practically unbroken for 50 years, the official connection with the Weather Bureau ceasing with the establishment of the regular station at Peoria in 1905. Doctor Brendel was a physician of excellent standing, a botanist of note, author of a 90-page pamphlet entitled "Flora Peoriana," a man of scientific tastes, and of deep devotion to his work. It is related of him on the best of authority that in his later years, while seriously ill and lying apparently unconscious, he would still rouse regularly about the observation hour and direct the nurses to read the thermometers. Doctor Brendel's death occurred August 10, 1912, at the advanced age of nearly 93 years.

The most remarkable substation record in Illinois is that of John West James in Riley Township near Marengo. Mr. James moved to Illinois from New York in 1860, beginning his work as voluntary observer for the Smithsonian Institution in that year and continuing almost without interruption until his last illness in 1917, thus completing a gratuitous service of 57 years. This is the longest record by any cooperative observer in the State, and probably one of the longest in the United States. The entire record was made on the same farm, so far as the writer knows without change of location, and during the entire 57 years not a single month was missing. Mr. James was a student of astronomy and meteorology, and his weather reports were considered practically infallible. It is recalled that when the writer first met him in 1911 he confessed that he had missed a few days back in the seventies and he wished to know if that was very bad. He was a single man, living with relatives who were inclined to ridicule his interest in science but he continued the work nevertheless until called by death.

Whittaker Holden came from England. He began keeping the weather records at Aurora, Ill. in 1879, and continued until his death in 1913, a period of 34 years. He had collected an interesting group of aneroid barometers, and on one of his trips had brought back from Eng-

[1] Presented before American Meteorological Society, Des Moines, Iowa, Dec. 28, 1929.

land a bed hygrometer. The climate of England is damp and hotel rooms in many cases are not heated. Now to those who are not familiar with bed hygrometers explanation is made that this instrument is placed between the sheets to determine whether the bed is dry enough to occupy. Mr. Holden loved his weather work and the instruments he had in his possession. A few moments before he passed away he asked his daughter to bring his favorite barometer and he died with it in his hands. The daughter, Miss Alice M. Holden, took up the work, at first because she knew it would have pleased her father to have the records continue. She has rendered splendid service over a period of 16 years.

Of the present observers the three with longest service are O. C. Nussle, Walnut, Ill.; Prof. F. U. White, Galva, Ill.; and Prof. H. N. Pearce at Bloomington, Ill. Mr. Nussle is a druggist, with 39 years to his credit. He is only 67 years of age and we expect him to maintain the Walnut records for some years to come. Mr. White has served the Weather Bureau 38 years but he has been superintendent of schools at Galva even longer, a unique distinction for a school man in a small place. He is unusually active for a man of 71. The Bloomington station was taken over by Mr. Pearce in September, 1899, more than 30 years ago. In January, 1927, his health failed, but he was unwilling to give up the weather work and Mrs. Pearce has kindly cared for the observations since then. For many years he was a chemistry instructor in the Bloomington High School.

These are human interest stories that serve to illustrate the faithfulness and loyalty of the cooperative observer.

We are justly proud of our associates out in the State, both for the high quality of the work, and the promptness with which their reports are rendered. It is not believed that any voluntary service, in or out of the Weather Bureau, produces work of higher quality than that of the Illinois observers. In two consecutive years observations were lost for only one month at a single station. Of the nearly 900 reports due at the section center during the first eleven months of this year 97 per cent arrived before the 6th of the following month, the bulk of them on the 1st, 2d, and 3d. But seven reports were received after the 7th.

In order to secure a climatological service of the best type, it is obvious that an intelligent personnel is needed. To a certain extent the condition will correct itself by a process of elimination. The poor observer will lose interest and quit, but the efficient one will become more and more interested in his work, especially if encouraged, and will continue on for years. In making appointments we ascertain the applicant's age and occupation, find out something about the place available for the exposure of the instruments, and endeavor to have him properly recommended.

Considerable attention has been given in Illinois to the location and distribution of substations. As opportunity presented, areas not properly represented have been cared for and stations too close together have been eliminated or changed from full cooperative to precipitation only. In a number of instances they have been brought from farms to the residence districts of towns, thus facilitating mail service. With proper geographical distribution always in mind, an effort has been made to locate instruments in important towns or cities or at railroad junctions—places where there is a demand for the records. The awkward situation by which at times the weather station and postoffice have had different names has been entirely eliminated.

It must not be assumed that having selected a suitable personnel and properly arranged the stations the service will move forward by itself. The work of the section center has just begun. There are long years ahead of what the chairman of our program committee terms "encouragement for cooperative observers." What then?

The word "cooperative" has been hard worked in Illinois. The observers are doing their part in taking the observations and preparing and mailing the reports, accurately, promptly, and regularly. If we at the section center have contributed anything toward this cooperation it has been largely through personal contact. This personal contact, the writer believes, is the most important element in conducting a climatological service. The Weather Bureau desires accurate reports from the substation observers, neatly prepared, and promptly forwarded. We, at the section center, must guide and advise these volunteers. Can we do this successfully with strangers?

In Illinois the section director does practically all of the inspection work, not because he can do it better, but the observers in the field look to him as the responsible head of the service and desire to meet the person with whom they feel they are cooperating. An effort is made to visit the stations every three years or to adhere to that policy as closely as possible.

We endeavor not to be too hasty in our substation inspection work. It does not require much time to look over the instruments and give the observer brief instructions, but is that enough? In our inspection work we average a station a day for the full cooperative stations and a little less time for the precipitation stations. This includes rail travel.

Very often the observer, because of his regular work, is not available until late in the day. In the meantime the inspector tests and cleans the thermometers, including the metal backs, cleans and oils the support, tests the rain gage, arranges for repairs, and prepares the inspection report and the report of Description of Station and Instruments, making new measurements if any changes have taken place since the last inspection. Then when the observer is free we have a good visit and go thoroughly into the observational work, but do not talk about the Weather Bureau exclusively.

On several occasions observers have remarked that if Uncle Sam takes the trouble to send an official to cooperative stations their records must be of importance. This idea encourages them to renewed interest in the work and is another argument in favor of frequent and regular inspections.

A section director who goes out in the field and becomes acquainted with the observers in their home surroundings is in a position to aid and encourage them in many ways, and thus secure that good will that results in efficiency and makes the work more agreeable for all concerned.

In the Illinois section there are 2 observers who have each served 35 years, several have served more than 25 years, and 19 in excess of 15 years. The older ones have been visited by the present section director four times and many others three times, and of the 81 in the State there are only 8 that he is not acquainted with personally. Naturally we have become friends, and when we ask a favor, such as improvement in the reports or earlier mailing, the observer is glad to comply, and he in turn knows that we will do what we can to produce cooperative conditions that are pleasant and interesting.

In the correspondence with the substations in the field the men at the section center endeavor to not only be courteous, but to show a friendly interest. For several

years we issued a little "length of service" pamphlet and a list of the veterans is published once each year in Climatological Data. Copies of Tycos and the Bulletin of the American Meteorological Society are passed about among the observers and publications are sometimes secured from the central office for distribution.

And so it is seen that hearty cooperation is necessary in the successful conduct of a climatological service and personal contact is probably the most important element in attaining that cooperation.

ARE PRESENT METHODS IN COOPERATIVE CLIMATOLOGICAL WORK EFFECTUAL?

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Some difficulty was experienced in choosing for this brief paper a title that would indicate exactly the things the writer had in mind to discuss; and since the title was submitted some doubt has remained in his mind as to whether it carries his meaning. Therefore, at the outset permit him to say that there is no intention of reflecting upon the character of the service rendered by the cooperative observer, nor in any manner whatever of impeaching his weather record. His importance in the field of climatology, and his public spiritedness and devotion to duty without compensation, oftentimes under trying circumstances, are highly appreciated by the great body of investigators who reap the benefit of his labors, but are appreciated by none more than by the officials of the Weather Bureau so closely in contact with his work. Nevertheless, in passing it may be said that the cooperative observer par excellence is, at least in some sections, becoming more and more a rara avis, and consequently the maintenance of satisfactory cooperative weather stations in such sections is becoming likewise more and more difficult. This is especially true of the more populous and urban regions. This situation was recognized by the director of the Iowa climatological section, and was commented on by him in his report for January, 1928. It has also been the experience of the writer in his work in the Indiana climatological section. The causes, however, have nothing to do with the purpose of this paper, and may, therefore, be left for possible future consideration.

As there is no intention of reflecting on the work of the cooperative observer, also neither is there any intention of intimating that the presentation of climatological data as published by the Weather Bureau in its several section monthlies is of other than very great value to the bureau itself as well as to many and varied interests and professions. The ever increasing demand for such data by these industries and professions is proof positive of the important service performed in securing and distributing climatological information.

However, if there be in the observations, records, and subsequent publications, any matters that may be more accurately interpreted, or presented to better advantage, such matters, even though of minor importance are worthy of some consideration. In the course of nearly 20 years of practice in the inspection of cooperative climatological data and of preparing the same for publication there have arisen in the mind of the writer two general questions, each with several separate divisions:

(*1*) As to whether in the inspection and final summarizing of cooperative records at the section center certain corrections or adjustments before publication are desirable; and,

(*2*) As to whether the climatological data presented in the printed section monthlies could to advantage be curtailed, added to, or changed in any respect.

As to the first of these general questions, extended comparison of Indiana cooperative data with those of the regular Weather Bureau stations within and near the section boundaries, as well as similar though less extended comparisons of the data in other sections, has lead to the following conclusions, which are submitted with some comment thereon:

(*a*) That for much of the country, cooperative records usually average a greater number of days with maximum temperatures of 90° and higher, and also a greater number of days with minimum temperatures of 32° and lower, than do the records of the regular Weather Bureau stations in and around the same section. Why is this and what is the effect, if any, upon the mean temperature computed for the section?

It will be recalled that the meteorological day at the cooperative station usually ends at some afternoon hour near sunset or earlier, and that the temperature readings then obtained are for the preceding 24 hours. As the highest temperature of the day occurs most frequently during the early to late afternoon, it is naturally to be expected that days of any maximum temperature chosen for count will be recorded in greater number at the cooperative station than will be the case at the regular Weather Bureau station where the day closes at midnight. In other words, the maximum temperature of a single calendar day, by reason of the fact that it usually occurs in the afternoon, is often carried into the cooperative record as the maximum temperature of two days instead of one; so increasing the total number of days of certain high temperatures, and also increasing slightly the mean maximum temperature computed for that particular month.

The cause of the recorded larger number of days with minimum temperature of say 32° or lower at many cooperative stations—not so many more, however, as is the case with high temperature records—is different. Except at the comparatively few cooperative stations taking observations in the morning at about 7 a. m., the hour of the cooperative observation has little effect on the number of such days recorded. Most of the regular Weather Bureau stations are in the central business sections of the larger cities, where the minimum temperature that usually occurs during the late night or early morning is held up somewhat by the greater heat of large buildings and pavements, and by the effect of overhanging smoke in hindering radiation of heat. On the other hand, cooperative stations usually have a much more open exposure, and even if located in the large cities are most often to be found in the outlying residential sections. In such places the fall of temperature through the night to its minimum is not retarded by the conditions mentioned in the preceding sentence; and so, consequently, the cooperative station more often records a low temperature of say 32° or lower than does the regular Weather Bureau station.

As the greater number of days with high temperatures recorded at cooperative stations must result—and improperly so—in an erroneous idea of the frequency of such days in that locality, and a slightly higher mean monthly maximum temperature than should be the case,

so also does the greater number of days with low temperature of say 32° result—but properly so—in a lower mean monthly minimum temperature than is the case for the regular Weather Bureau stations in the same region. While these differences, as reflected in averages, are but slight, they should not be discarded from consideration, and the question arises as to whether it may not be practicable and advisable for the reviewing officials at the section centers to adjust cooperative temperature records to the midnight to midnight basis by a careful comparison of the hourly trend of temperature as shown by the thermograph traces of the Weather Bureau stations in and around the section. It is believed that this matter is worthy of study and experimental tests in practically all of the climatological sections of the country.

(*b*) Cooperative station records usually average a smaller number of days with precipitation of the amount of 0.01 inch or more as compared with the records of regular Weather Bureau stations in and around the same region. A study of the hourly precipitation records of the Indianapolis station of the Weather Bureau, and a previous study of similar data of the Chicago station covering a period of 10 years, has shown that on the whole precipitation in the region of those two stations occurs more frequently during the afternoon hours than it does at midnight. It might be expected that, as a natural result, the measurement of precipitation at any afternoon hour of observation, say 5 p. m., would more often give measureable amounts of 0.01 inch or more on both sides of the hour than would be the case were the observation made at midnight. In other words, it is apparently reasonable to expect that in the case of an observation made in the late afternoon a single rainfall will often appear in the record as two days of rain; whereas a fewer number of days with rain would appear if the observation were made at midnight. This reasoning would lead us to the conclusion that cooperative records average a larger number of days with 0.01 inch or more precipitation than the records of regular Weather Bureau stations, and it is rather astonishing to find that such is not the case.

For instance, in the records of 1926, the climatological section of Arkansas from its complete list of cooperative and Weather Bureau stations averaged 88 so-called rainy days, while the average to be obtained from the records of the regular Weather Bureau stations in and near the borders of Arkansas is 106, a greater number by 18 rainy days; Texas from its complete list averaged 70 rainy days, while its Weather Bureau list averaged 94, greater by 24 rainy days; lower Michigan from its complete list averaged 115 rainy days, while its Weather Bureau list averaged 153, greater by 38 rainy days; New England from its complete list averaged 127 rainy days, while its Weather Bureau list averaged 134, greater by 7 rainy days; Virginia from its complete list averaged 102 rainy days, while its Weather Bureau list averaged 128, greater by 26 rainy days; Wyoming from its complete list averaged 76 rainy days, while its Weather Bureau list averaged 110, greater by 34 rainy days; eastern Washington from its complete list averaged 84 rainy days, while its Weather Bureau list averaged 89, greater by 5 rainy days; western Washington from its complete list averaged 152 rainy says, while its Weather Bureau list averaged 163, greater by 11 rainy days.

Similar results were obtained from the records of other years and other sections, so that it apparently is the rule that precipitation is less frequent as reflected by the cooperative records than as reflected by the records of regular Weather Bureau stations, notwithstanding any effect that might be expected from the differing 24-hour periods for which the measurements are made. The writer has no explanation to offer, but submits the fact as one needing careful study by the several section officials with the view of determining what adjustments, if any, are practicable in the interest of consistency.

(*c*) Cooperative records usually average a smaller number of days called "partly cloudy" as compared with the records of regular Weather Bureau stations of the same region, the difference being accounted for in the recorded number of clear or of cloudy days. In this connection it is proper to observe that cooperative observers, although conscientious in the performance of their duties as such, are yet mostly very busy persons, absorbed throughout the day in close attention to the needs of an exacting business, oftentimes indoors. Observations of the condition of the sky may therefore be necessarily infrequent; and as a result the judgment as to the character of the day may be based more or less upon the early morning or late afternoon observation than upon several scannings made during the course of the day. In this connection the question arises whether it would not be better if the cooperative observer so situated recorded only the condition of cloudiness at the actual time of his observation, indicating his record as such, permitting the records of the regular Weather Bureau stations to indicate the general character of the daytime hours over the section.

As to the second general question mentioned in the first part of this paper—as to whether the climatological data presented in the printed section monthlies could to advantage be curtailed, added to, or changed in any respect—experience during nearly 30 years in answering requests for climatological data has led to the following conclusions:

(*a*) That there is no demand for, and practically no use for, data on greatest daily range in temperature as printed in the monthly section reports in the general table on the second page of each, and that some other useful data might therefore be substituted to advantage. These greatest daily ranges as printed are computed from the maximum and minimum temperatures in a 24-hour period that does not usually coincide with the calendar day, except in the case of the regular Weather Bureau stations and a very few others. The ranges so obtained, particularly during long periods of rising or falling temperature, often do not approximate even closely the true daily ranges; and especially is this the case of cooperative records based on morning observations, of which most climatological sections have some number.

(*b*) That the mean monthly temperatures shown in the same general table for the several stations do not furnish sufficient information as to the general temperature characteristics of the month. The same station may have the same mean monthly temperature in two or more years—or two different stations may have the same mean monthly temperature in the same year—and yet the fluctuations of temperature from day to night be totally different for any two compared. However, if instead of the greatest daily range mentioned in the preceding paragraph, the mean daily range were printed, that item would furnish good information on which to base comparisons from month to month, and from station to station, because one-half of the mean range added to and subtracted from the mean monthly temperature gives the mean maximum and the mean minimum temperature to a sufficiently accurate degree.

(c) That, while division and section mean monthly temperatures are of some value for purposes of comparison in more or less level areas, they are of little use for that purpose in many rugged or mountainous regions. However, mean monthly temperatures in such rugged regions, if arranged and averaged by elevations, may serve many useful purposes, and tend to establish practically the effect of altitude on temperature, just as in the more level areas north to south division mean temperatures establish the variation due to latitude.

For instance, in the published climatological data for Colorado for April, 1927, there is no separation of the State into smaller divisions, but cooperative and other stations are arranged alphabetically in one list. The mean temperature for the entire State was computed from the several mean temperatures in this list by averaging them in one operation, and was found to be 44.2°.

If, however, we arrange stations and compute mean temperatures by altitudes from lowest to highest in several zones, say of 1,000 feet each, we have, beginning with the lowest zone, results as follows: 3,000 to 4,000 feet, 6 stations, mean temperature, 52.1°; 4,000 to 5,000 feet, 16 stations, mean temperature, 49.9°; 5,000 to 6,000 feet, 13 stations, mean temperature, 48.6°; 6,000 to 7,000 feet, 14 stations, mean temperature, 44.5°; 7,000 to 8,000 feet, 8 stations, mean temperature, 40.3°; 8,000 to 9,000 feet, 11 stations, mean temperature, 36.0°; 9,000 to 10,000 feet, 4 stations, mean temperature, 35.5°; 10,000 feet and higher, 4 stations, mean temperature, 33.2°.

This arrangement and averaging shows a more or less gradual drop in mean temperature from the lower to the higher zones. The average altitude computed from the elevations of the entire number of stations in the list is 6,416 feet, which falls in the 6,000 to 7,000 foot zone, the mean temperature of which, as obtained above, is 44.5°, only 0.3° higher than the mean temperature for the State (44.2°) as printed. Similar results have been secured from the data for other mountain States.

(d) That, while the demand for climatological data is constantly growing, and while inquiries are ever increasing in variety, response to which requires more and more time for special compilation, the limits of the publication have remained practically constant for more than a decade. The need for more detailed data on storm damage alone would frequently justify the extension of the printed matter by practically a page; and if we could insert in this publication data to answer inquiries regarding frequency of rainfalls and snowfalls of stated amounts, river stages and flood conditions, more complete information as to the effect of weather on crops, etc., still another page would be none too much.

Such questions as those briefly discussed in this paper, together with many others, some general, some pertinent to individual sections, are the problems of the Weather Bureau section director in serving the public interest. Their consideration, it is believed, should receive the attention of more than the individual official in his section; and in conclusion the writer begs leave to express the hope that at some time in the future it may be found practicable for the officials in charge of the climatological work of the bureau, both at the central office and in the field, to congregate from time to time to discuss in body these and similar questions, and to provide as far as practicable uniform and increasingly effectual methods of handling and publishing these valuable records of the cooperative climatological service.

FOREST-TREE DISEASES CAUSED BY METEOROLOGICAL CONDITIONS [1]

By ERNEST E. HUBERT, Professor of Forestry
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When crops are poor, when epidemics of human disease are prevalent, or when forest fires rage over a wide territory, we are constantly reminded "It's the weather." The weather appears to be held responsible for many things, including rheumatism and the irregularities in the yearly growth of trees. Now come the forest pathologists to fill the cup to overflowing by stating quite calmly that meteorological conditions are responsible for a considerable number of important tree diseases. Fortunately, many of these diseases are of minor importance economically and do not greatly affect the life of a stand of timber. Others, however, cause considerable loss.

In a discussion of tree diseases, it is always helpful to group them under two main heads—(1) diseases caused by organic agencies such as fungi and mistletoes and (2) diseases caused by physiogenic agencies such as heat, frost, wind, and similar physical causes. The physiogenic diseases include all causes of disease which are produced by various atmospheric changes and disturbances, as follows: Sunscald, drought, wilting, frost cracks, frost heaving, frost bite, wind breakage, wind throw, wind deformation, red belt, sun scorch, too much or too little light, lightning injury, ice injury (sleet storms), snow breakage, snow smothering, snow heating, subsnow fungi, root suffocation (too much rain), gas injury, and dust injury.

FROST INJURY

Much has already been written on the cause and control of frost injury brought about by low temperature. In the literature are to be found several types of frost injury designated by various terms. Early and late frost injury, discoloration, wrinkling, slitting of leaves, and frost cracks are common injuries which result from the effects of direct freezing. Other types of injury such as "red belt" and a closely related one which may be aptly termed "sun scorch" or "sun burn" appear to be caused primarily by low temperatures but require the action of meteorological factors other than frost to bring about actual damage and the accompanying symptoms.

Frost injury in one form or another is fairly common in all regions where the temperatures fall below the freezing point of water. In the colder climates severe injury frequently occurs in seedling stock grown in forest nurseries and to transplanted stock. In the forested regions certain areas are known as frost pockets or frost centers in which frost injury is apparently more prevalent than in the adjacent areas. Topography and exposure are factors of importance which may account for such areas. Sun scorch and red-belt injury are confined to the coniferous forests and are most commonly, if not exclusively, reported occurring in the western coniferous belt.

Wilting takes place after severe frost injury and is followed by discoloration of the leaves and later on by a water-soaked appearance of the tissues. In some species the young bark turns a dark color. Tender tips and stems and young leaves are most susceptible and for this reason nursery stock often suffers severely.

Another common symptom of frost injury is the well-known frost crack or frost split which occurs in the trunks of some of our forest and ornamental trees. These radial

[1] Presented before the American Meteorological Society, Pacific Division of the A. A. A. S., Eugene, Oreg., June 20, 1930.

cracks are usually found in the lower trunks, originating in the hollows of the root collar between the root spurs and extending several feet up the tree. They usually show considerable callus growth where healing of this type of wound is in progress. Repeated opening of the healed crack by subsequent frost and wind action forms on either side of the crack large callus growths which project some distance out from the normal circumference of the trunk and are often called "frost ribs." These cracks also extend into the heartwood for considerable distances and render the lower trunk useless for high-grade lumber or timber. Circular cracks or frost shakes are formed in some trees by low temperatures. Gummosis and resinosis are signs accompanying such injuries.

Since the younger and more delicate tissues are most susceptible to low temperatures, injury to leaders and to branch tips is of common occurrence in the frost belts. The resulting wilting and die-back are also symptoms of fungous diseases and care must be exercised in determining the original agency causing the prime injury. The tips of young trees in our western conifer forests frequently suffer from a peculiar type of frost or winter injury. The leader and one to several whorls of branches down from the top turn a bright wine red soon after bright sunlight followed a "cold snap." The whorls on the lower trunk which were buried in snow or otherwise protected from rapid thawing by sunlight remain green and the branches above snow level, or those exposed to the sun, become reddish in color. The tips and discolored branches die, causing deformed tops. In severe case the young growth is killed back until the tree has developed an abnormal bushy form.

Temperatures below the freezing point of water (0° Centigrade or 32° Fahrenheit) are indicated in the use of the term frost as an agency of tree diseases. Late frosts in the spring injure tender growing tissues while early frosts in the fall injure older plant tissues before they have become fully prepared for winter dormancy. Very susceptible young tissues may be injured at temperatures slightly above 32° F.

When the tissues of leaves and young stems are frosted water is either withdrawn into the intercellular spaces where ice crystals are formed, or the ice is formed partly or wholly within the cells. In either case water is extracted from the protoplasm and wilting takes place due to the reduced turgidity of the cells. If thawing is brought about slowly the water is reabsorbed by the cells without resulting damage and the plant again resumes its erect position. There are differences of opinion as to when and how frost action may prove fatal to the plant. Hartig (1), discussing the various angles of this problem, points out that the death of a plant by frost during winter bears a close resemblance to the effects of drought. Thus red-belt injury may be caused by a sudden thawing of the leaves in the crown accompanied by transpiration which removes more moisture from the leaves than can be supplied by the frozen trunk and roots. If the water deficiency in the frozen cells exceeds a certain limit and this amount can not be replaced by the adjacent tissues or supplied by the roots, the tissues die. Neger (2) has found that sunlight plays an important part in the revival of chlorophyll tissue which has been frozen. Conifers subjected to low temperatures revive fully if allowed to recover slowly in darkness, but develop discolored needles and cast them, in the case of spruce, if the frozen plants are allowed to thaw out in full sunlight. Photosynthetic activity during the time when little water is available and the cell sap is highly concentrated may bring about chemical changes which result in the death of the protoplasm. Hartig indicates that drought during open sunny winters when the roots are frozen accounts for considerable winter-killing. The conclusion is that death due to frost takes place at the time of thawing even in such cases, for it is upon the return of temperatures favorable to metabolism that the cells become active and die from lack of sufficient water.

RED BELT

In typical red belt there is a tendency for the older needles to be cast first and for the youngest needles to remain uninjured and attached to the tree. This is particularly noticeable in such species as Douglas fir (*Pseudotsuga taxifolia*) and Englemann spruce (*Picea engelmanii*), where all the needles but the youngest are cast and in addition the buds are often killed. In such cases the characteristic red crown is missing. Red belt is most pronounced on trees exposed to the east, south, and west, and on those bordering the stands or on isolated trees. There is a marked banding or grouping shown by the discolored trees which seems to follow the conformations of the topography, in some cases almost paralleling the contour lines (1, 3, 4, 5). These bands may be quite regular or irregular and may vary in width. Again, as in the 1924 winter injury to conifers in the Montana, Idaho, Washington, and British Columbia areas, the discoloration was fairly general with no distinct banding in evidence. Whenever the lower branches of red belt, winterkill, or sun scorch trees are buried in the snow they usually escape injury and bear a full set of healthy green needles. With regard to gross symptoms and primary agencies the two diseases known as red belt and winterkill may well be identical.

The symptoms of another type of winter disease known as sun scorch, sun burn, and sun scald are somewhat different from the above. Discoloration and death of the needles and tops, sometimes the entire tree, occurs on exposed trees, particularly the smaller isolated trees bordering a dense stand or growing along the edges of highways and railroad rights of way. The color is a bright wine red to reddish brown depending upon the species, and the discolored needles usually cling to the branch for a considerable period after injury has taken place. The lower crowns or individual branches, protected by snow banks, snow coverings or by neighboring trees, remain green. This presents a characteristic appearance—a dead and discolored upper crown with a green lower crown. The south, southeast, or southwest sides of affected trees show the greatest amount of discoloration and injury and trees growing in situations exposed to sunlight show the most severe damage. Many of the white firs (*Abies grandis*) and western red cedars (*Thuja plicata*) show a dwarfed or bunchy type of growth due to the killing of the leader and some of the upper branches. Examination of the stems of sun-scorched conifers in the region below and immediately above the edge of the dead tissue disclosed no signs of frost rings in the annual rings of the wood.

It is believed that, in all the types included under this group of physiogenic diseases, the direct cause of death is a shortage of water making itself felt in the needle or leaf tissues. In drought it may be the rapid lowering of the soil water table, a porous and shallow soil, injury to the root system, too rapid transpiration, prolonged hot, dry periods in the growing season, sudden exposure by thinning or removal of trees. In the case of winterkill and red belt, death is apparently caused by excessive transpiration of the needles during warm, sunny periods in the winter when the ground, roots, and trunk of the

tree are frozen. Such sudden warm periods or "chinooks," as they are known in the northwest, usually follow a period of unusually low temperatures. During this warm period the heat and sunlight stimulate the leaves into activity and sufficient transpiration takes place to exhaust the available water. In this way the water column is broken since no water is obtainable from the frozen branch and trunk and the needles are unable to continue their normal activity and soon die.

Bright sunlight and rising temperatures, following a sudden period of low temperature, appear to be responsible for the injury known as sun scorch and the characteristic symptoms help to bear out this assumption. Neger (2) states that it is not so much the freezing action that causes the damage as it is the action of direct sunlight in rapid thawing and activating the photosynthetic cells of the needles. He conducted some interesting freezing experiments with spruce branches and found that the frozen branches which were revived in the direct sunlight developed discolored needles which were later shed, while those branches revived in a dark chamber recovered completely. Similar experiments were conducted by myself on branches of Douglas fir, lodgepole pine, yellow pine, western white pine, western hemlock, lowland white fir, concolor fir, Engelmann spruce, western red cedar, western larch, and jack pine. Two sets of branches of the above species were placed in an electric refrigerator at a minimum temperature of 18° F. for 16 hours. At the end of this period one set of branches was placed in the direct sunlight, their stems in water, while the other set, also supplied with water, was placed in a darkened cupboard. At the end of a 12-hour period the set exposed to sunlight showed a large number, nearly 50 per cent, of its needles discolored a light reddish brown and a casting of the injured needles had already begun on the Douglas fir, spruce, and larch branches. The set which thawed out in darkness under ordinary room temperatures remained green and healthy in appearance.

The bronzing of broadleaf foliage (6) may have its origin in a deficiency of water and it is common during dry seasons to find the leaves of mountain alder (*Alnus tenuifolia*), serviceberry (*Amelanchier alnifolia*), and occasionally of birches (*Betula spp.*) showing typical reddish brown discolorations in the leaf areas between the principal veins, known as the intercostal areas.

The direct cause of death in all such cases where frost and other agencies such as sunlight and rapidly rising temperatures seem to be coordinated, is the subject of much discourse. Is it the freezing or the formation of ice crystals that kills? Or is it the withdrawal of necessary water or a disturbance of the chemical balance within the frozen cell that results in injury or death? Abbe (7) ably summarizes the present concept regarding these questions as follows:

> As the temperature of the plant cools the water exuding from the individual cells leaves a more condensed sap behind and the intercellular spaces are filled with purer water. Owing to capillary phenomena this water is not easily frozen until it has been cooled several degrees below the freezing point, and then its temperature suddenly rises to 32° F., as in the ordinary experimentation of the physical laboratory. The water within the cells is of course not yet frozen, being a more condensed sap, whose freezing point is usually lower than that of pure water. If now the temperature falls still lower, the ice cools, and eventually the sap within the cell is not more than sufficient to fill up the space formerly occupied by the water that exuded. If now the plant thaws out, the great mass of intercellular water escapes by transpiration. A little may go back into the cells, but this is a small percentage and oftentimes none. The plant wilts by the rapid loss of this water. Furthermore, a chemical change takes place in the cells by the excretion of pure water, and the cell sap that is left behind constitutes a new chemical compound. Such cells now change their character and their relation to the growth of the plant. Many of the excrescences and the diseases formerly supposed to be due to bacteria, or fungi, or parasites are found to be due to the chemical changes that have taken place within the cells in consequence of freezing. Thus Hartig shows that the frost *krebs*, or excrescence on trees, is a growth due to the effort of the plant to get rid of or cover up the dead cells produced by frost. When a frozen plant is young and tender and its leaves immature, the exudation through its tender cell walls may lie directly on the outside of the cuticle, but as the cuticle hardens in the mature plant, and the development of stomata becomes more complete, the greater part of the exuded water and its resulting ice is in the intercellular spaces. When the frozen plant is thawed out and evaporation is rapid, the loss of water either from the surface of the tender plant or through the stomata of the mature plant is much more rapid than under normal conditions and the plant wilts, but when there is no evaporation, the sap has time to return into the cells, and the wilting is not so severe. Therefore it is proper to say that the injury is not done by the more or less rapid thawing, but by the more or less rapid evaporation that accompanies the thawing. If similar plants are thawed out under warm and cold water, respectively, the rate of thawing has no influence on its health, as was shown by Sachs long ago. It is now seen that this is because in both these cases there is no special chance for evaporation, and the sap was able to go back into the cells; the contrary occurs when the plant thaws in the open air.

EFFECT OF HEAT

High temperatures cause wilting and heat lesions in seedlings and transplants, usually resulting in death; and, furthermore, may kill tender, frozen, or exposed young bark tissues causing a canker formation on the trunk, limb crotches, or larger limbs. The conditions, other than temperature, surrounding the plant at the time of injury are important with respect to the amount of damage caused. Heat cankers or bark scorch may be produced on the southwest sides of tree trunks when such trees are suddenly released from a dense shaded stand through logging operations, openings made for roads, highways, rights of way, fire lanes, or by the death of neighboring trees. These injuries, if severe, may girdle the tree, otherwise they form infection courts for the entrance of wood-inhabiting fungi. The color of the soil very markedly controls the damage caused by the high temperatures of direct sunlight. The darker soils, particularly the fire swept, charcoal covered soils, due to their high and rapid absorption of heat cause death to seedlings growing on them. Hartley (3), specifying measures to prevent stem lesions or whitespot injury of seedlings due to heat, says "Soil with loose texture or dark surface is presumed most likely to overheat at the surface."

A record, made by Forest Service investigators at the Wind River Valley Experiment Station, Washington, of seedling survival on two areas—one having a mineral soil, the other a black charcoal surface resulting from fire—showed a surface soil temperature of 143° F. and a loss of 100 per cent of the seedlings in three days' time, while on the yellow soil the temperature reached 125° F. with but a 16 per cent loss of seedlings. Neger (2, p. 25) states that spruce and pine seedlings can bear a maximum temperature of 54° C. without serious injury.

Both broadleaf and coniferous trees are subject to this type of disease. The more tolerant species, those possessing thin bark and those growing in moist sites, when exposed to sunlight, suffer severely. The most common examples of bark scorch and heat canker are to be found on orchard, shade and ornamental trees. Of the shade trees the maples, birches and beeches appear to be quite susceptible to this injury. Among the conifers, the white pines, certain spruces, Douglas fir and the true firs are sensitive to heat when the young tender bark becomes exposed to sunlight.

The primary cause of injury in this type of disease is the high temperatures affecting young, tender tissues.

Whether these high temperatures cause death of the tissues by killing or inactivating the protoplasm in the cells or by a form of dessication is not clearly indicated in the literature on the subject. It would seem that the lowering of the available water supply to a critical point through dessication would be a very important factor in reducing the resistance of the younger bark tissues to the injurious action of overheating. The overheating of leaves when a very high relative humidity is present, according to Neger (2, p. 24), results in a defoliation which is frequently more pronounced within the crown than on the outer parts.

Heald (8, p. 174) is of the opinion that winter injury is probably a more common cause of canker on both fruit and forest trees than the high temperatures due to bright sunlight. He states, however, that sun scald of some thin barked trees results from overheating during the intense sunshine and high temperatures of midsummer, coupled with a drying out of the tissues. A type of sun scald called winter sun scald is due to a combination of freezing temperatures followed by exposure of the frozen tissues to direct sunlight of sufficient intensity to cause injury.

SMOKE INJURY

The gases escaping into the air as the result of the incomplete combustion of coal, or the smelting of sulphurous and other ores, cause symptoms in trees which are recognized as signs of smoke injury. While the above two sources of harmful gases are the most important economically, there are a number of other sources which are accountable for similar, if less harmful, diseases.

Sulphur dioxide (SO_2) is perhaps the most common and the most injurious of the gases found in smoke. Hydrochloric acid, hydrofluoric acid, chlorine, as well as the finely divided solids found in smoke, have been recorded as harmful to forest trees. Previous work has shown, however, that smoke dust plays but a minor part in causing injury to forest trees.

While gases from industrial plants diffused in the air are the prime cause of the disease of coniters and hardwoods resulting in a wine red to reddish brown discloration of the foliage, the part played by the relative humidity, sunlight, and air currents is so important that I have included this disease in my discussion. Smoke injury takes place only under specific conditions; i. e., when the relative humidity is fairly high, when sunlight activates the foliage, and when air currents move the fumes to the susceptible trees rapidly enough to prevent too great diffusion of the harmful gases. In this manner meteorological conditions play most vital parts in the injury and death of forest trees by gases in the air. The effect produced on the host by smelter fumes, for example, so closely resembles the symptoms of several other diseases of conifers, including the various types of winter injury, that great difficulty is experienced in diagnosing the true cause of the damage when it occurs.

RAIN, HAIL, AND SNOW INJURY

These meteorological agencies cause injuries which are usually of the type of wounds in the tender bark tissues or of direct breakage of tips or branches. These injuries are important in that they frequently form the infection courts for parasitic and heartrot fungi. The sleet storms common in the Lake States and North Atlantic States often result in very serious damage to trees over large areas.

An estimate of the total weight of sleet borne by poles supporting telephone wires during a severe sleet storm in Wisconsin during the early part of March, 1922, gives us some idea of the strain which forest and shade trees are under when severe snow and sleet storms visit a region. Estimating that each linear foot of wire supported 4 pounds of ice, the 32-wire line with a span of 120 feet between poles had to carry a weight of 15,360 pounds in the face of a terrific gale. Even under such conditions the failures in the line were frequently traced to poles which had been weakened by decay at the ground line.

WINDFALL OR WINDTHROW

While not a true agency of disease excepting cases where prevailing winds acting upon exposed trees, such as in high elevations, cause a deformity of the branches and crown, yet wind action is an important factor in causing considerable loss in timber stands. Trees weakened by such factors as decay fungi, shallow root systems, moist, loose soils, sudden exposure by cuttings, site, etc., are very prone to be overturned by the force of strong winds. Within recent years large areas of timberland have suffered this type of injury. The breakage of tree trunks and of branches often results from high-velocity winds.

Such "blowdowns," as they are termed along the Pacific coast, have occurred in recent years along the Olympic Peninsula, where large areas of mature timber have been swept to the ground. The tangled condition resulting from windfall and the isolated areas in which they frequently are found, makes it impossible to salvage the timber before deterioration of the sapwood takes place. Within two to three years much of the sapwood and some of the heartwood is deteriorated through sap stain and decay fungi.

ELECTRICAL OR LIGHTNING INJURY

Lightning, aside from the setting of forest fires, causes considerable injury to trees in a forest. The breakage of tree parts and the splitting and shattering of tree trunks are the more conspicuous signs of lightning injury. However, the injury due to minor lightning bolts, to spray lightning, for example, is often hidden beneath the bark and reveals itself only as lightning scars in the annual rings. These false rings along with those produced by frost and other pathological agencies are a common source of error in counting the annual rings of a tree in an attempt to determine accurately its age or an historical date in the life history of the tree.

Lightning rings are common in certain species of trees and in trees growing in lightning zones. Sitka spruce, prized for its strength properties and light weight in airplane construction, frequently shows these false rings caused by lightning. As defects in airplane wood or woods requiring rigid strength specifications, these hidden injuries are of considerable economic importance, since failure under stress is most likely to take place along a false ring.

Before closing it will be of interest to dwell for a moment on the topic of ring or annual growth measurements in trees and their significance. Insufficient precipitation and the consequent lowering of the available water level in the soil is responsible for more injury to forest trees than most of us appreciate. Drought injury not only causes reduced growth and reduced vigor in trees, but it also predisposes the tree to attack by organisms which hasten its death. The reduction in annual growth alone represents an appreciable loss and this brings before us the interesting relationship between annual growth measurements and periodic changes in annual precipita-

tion. A tree reflects in its annual rings any reduction in growth activity caused by a large number of factors of which the annual supply of moisture is but one. Anything, from insect attacks, fire injuries, crowding of individual trees, sun scorch, to a variety of fungous and parasitic plant pests, may leave their record in decreased width of annual rings. The great problem is to eliminate all factors but one in each study. It is also a well-known fact that the width of the same annual rings varies considerably in different parts of the trunk. This makes it necessary to depend upon borings in various parts of the trunk from base to top. The frequent occurrence of false rings, double rings, and the absence of certain rings all contribute to the difficulty experienced in reading accurately the past history of the tree from the face of the stump.

I point out these facts to emphasize the large number of variables involved and the need of accumulating a great number of data on such growth correlation studies before conclusions may be hazarded.

An interesting piece of work of this nature has been done in our Idaho forests by Marshall (**9**), who found by measuring the ring growth of western white pine trees that the climate of northern Idaho has exhibited distinct wet and dry periods, varying in length from 20 to 40 or more years. The wet periods he found to be from 1706–1745, 1785–1825, and from 1846–1885. The dry periods were sandwiched in between the wet periods and were from 1746–1785, 1826–1845, and from 1886–1925.

These brief accounts represent but a few of the most important tree diseases which may be placed at the door of the weather man. There are a number of minor disturbances of the functions and damages to parts of trees which have not been touched upon. Enough has been presented to indicate the important rôle that meteorological conditions play in causing economic losses in our timber stands. Windthrow, winter injury, and drought injury are alone responsible for a very formidable loss over a period of years.

LITERATURE CITED

1. HARTIG, H.
   1894. Diseases of trees. Pp. 282–294. The Macmillan Co.
2. NEGER, F. W.
   1919. Die krankheiten unserer waldbäume (und wichtigsten gartengehölze), viii, p. 286, 22–25. Stuttgart.
3. HARTLEY, C. P.
   1912. Notes on winter-killing of forest trees. Forest Club (Nebr.) Annual, 4: 39–50.
   1918. Stem lesions caused by excessive heat. Jour. Ag. Res. 14: 602.
4. HEDGCOCK, G. G.
   1912. Winter-killing and smelter injury in the forests of Montana. Torreya, 12: 25–30.
5. HUBERT, E. E.
   1918. A report on the red belt injury of forest trees. Mont. State Forester, Bien. Report, 5: 33–38.
6. STONE, G. E.
   1916. Shade trees, characteristics, adaptations, diseases, and care. Mass. Ag. Exp. Sta. Bul. 170: 199–212.
7. ABBE, C.
   1895. The influence of cold on plants—a résumé. Exp. Sta. Record, 6: 777–781.
8. HEALD, F. D.
   1926. Manual of plant diseases. Pp. 136–138, 173–176. McGraw-Hill Book Co.
9. Marshall, R.
   1927. Influence of precipitation cycles on forestry. Jour. For. 25: 415–429.

THE RAINFALL OF SALVADOR [1]

By ADELBERT K. BOTTS

[Clark University, Worcester, Mass., December, 1930]

The rainfall of Salvador is an excellent example of west coast trade wind precipitation on the northern margin of the equatorial rainfall belt. The average annual rainfall of the country is 75 inches, an amount which is usually considered very bountiful. However, the distribution, both seasonal and areal, tends to restrict the benefits to certain rather definite periods and places.

Salvador is located on the western side of the Central American Cordilleras between the latitudes 13° and 14° 30′ N. The central part of the country is occupied by a belt of volcanoes, the highest one less than 8,000 feet high, and most of the peaks less than 5,000 feet high. The ridge is high enough, however, to affect the distribution of the rainfall. (Fig. 1.) The rainfall is considerably heavier on the side exposed to the ocean than it is in regions farther from and protected from the ocean. It is generally true that the amount of rainfall varies directly with the altitude of the land. (Fig. 2.)

A comparison of the average annual rainfall conditions of four representative stations shows further consistent modification with elevation. (Fig. 3.) Cutuco has two periods of maximum rainfall, one occurring in June and the other in September. They are separated by a period of distinctly diminished rainfall in July. For each of the remaining three stations the sharp distinction between wet and dry periods during the summer months is progressively modified with increasing altitude. San Salvador, 2,076 feet above the sea, has one continuous wet season lasting from April to November. It seems reasonable to assume that elevation is the controlling factor in this situation, since a study of data for other stations verifies the assumption and since the differences in latitude between the various stations is so slight as to be negligible.

Another modification resulting from increased elevation is decreased variability in amount of rainfall received from year to year. This fact is made evident by a comparison of the differences in the absolute extremes of rainfall by months for the various stations. On the Cutuco chart the vertical lines between extremes are very long. The length of corresponding lines for stations at higher elevations is generally shorter. A short line for any month indicates a slight variability in the rainfall for that month, which amounts in fact to greater uniformity from year to year. San Salvador, the station at the highest elevation, has, generally, the least monthly variability in rainfall from year to year. That seems to indicate that rainfall over a period of years is somewhat more uniform at high than at low elevations.

Rather important in the seasonal distribution of rainfall is the fact that a low total for a year does not imply a consistently dry year, nor a high total a consistently wet year. For Cutuco, the year with the least total rainfall (dotted line) shows rainfall much above the average for the first part of the rainy period, with June for that year the wettest June on record. In that case the second part of the rainy period was the one which cut down the total while the first half of the summer was wetter than usual.

[1] This study was presented to the Association of American Geographers, in their twenty-seventh annual meeting held at Clark University, Worcester, Mass., Dec. 29 to 31, 1930. Acknowledgment for the data upon which this study is based must be made to Mr. Fred Lavis, president of International Railways of Central America, who sent the material to Clark University. Use was made also of Mr. W. W. Reed's article, Climatological Data for Central America, in the MONTHLY WEATHER REVIEW, vol. 51, p. 133.

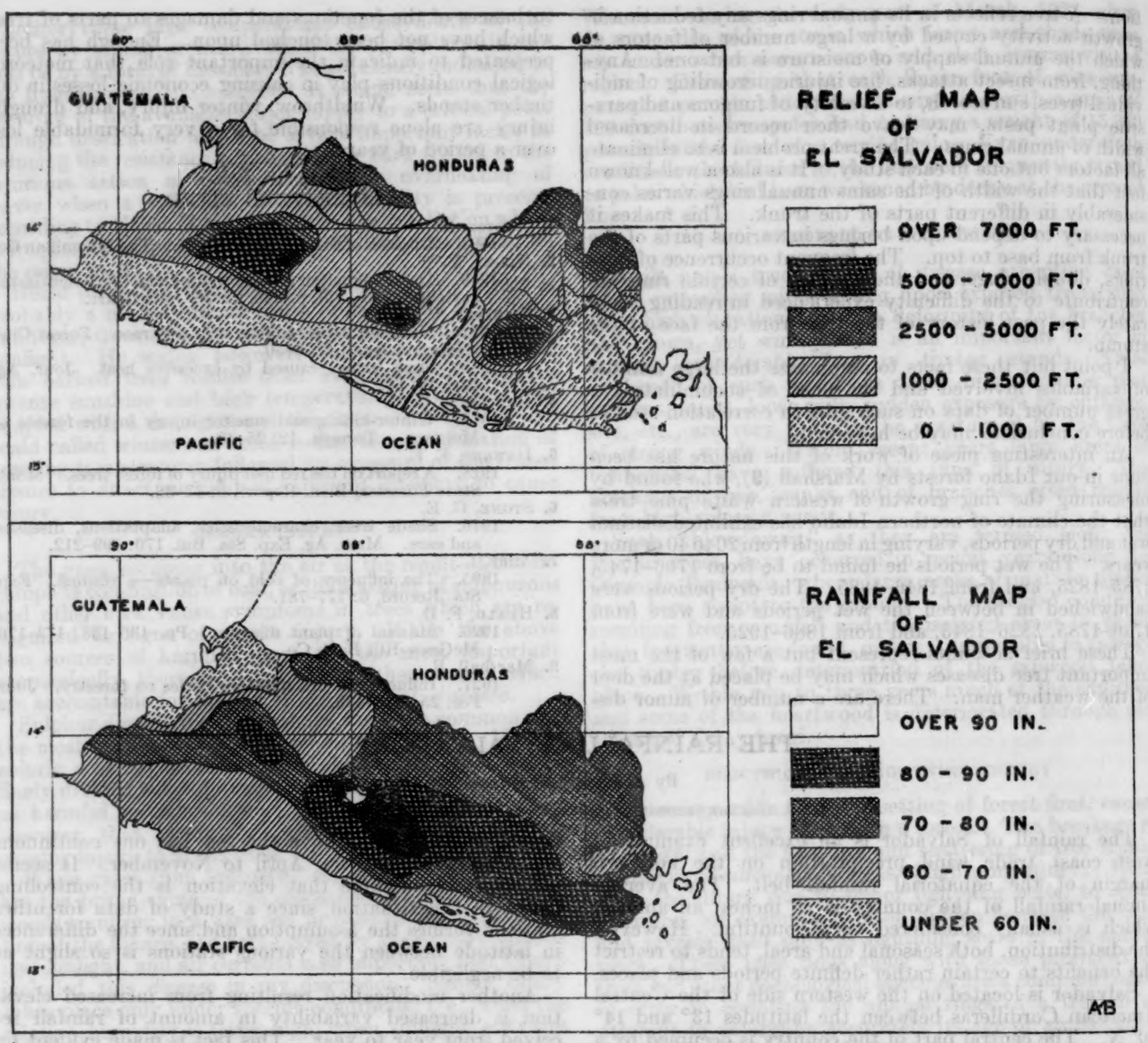

FIGURE 1.—The construction of these two maps was based upon data from 24 stations well distributed throughout the central, southern, and western parts of the country. The northeastern portion of both maps is based upon descriptions and upon older maps. Rainfall data are lacking for elevations higher than 3,000 feet

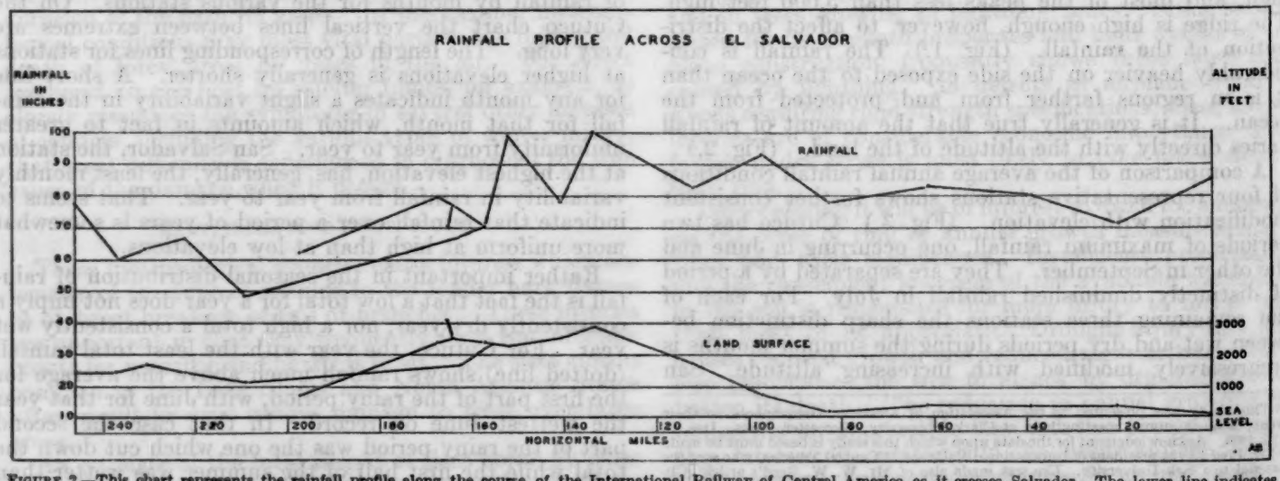

FIGURE 2.—This chart represents the rainfall profile along the course of the International Railway of Central America as it crosses Salvador. The lower line indicates the elevation of the land over which the railway travels. The dots at points where the lines are broken represent the positions of the various stations along the line for which data were available. The positions of the dots in the upper line indicate the amount of rainfall (average annual) for each station

In Olomega the season of least rainfall had the greatest October rainfall on record. Most of the other months that year were below average. In San Salvador the year with the least total registered the greatest May rainfall while the year with the greatest total had the driest October in seven years.

Such conditions are significant in the modifying effect they have upon rainfall distribution in years with extreme totals. A wet year may have drought conditions during months which are ordinarily wet, and, on the other hand, a dry year may have a month or two of unusual floods. Such conditions tend, for any station, to make the annual variability less in proportion than the variability for any month from year to year.

There appears to be rather a distinct relationship between the inclination of the sun's rays and the seasonal distribution of rainfall. Allowing about a month for lag, the dry season follows the period when the noon sun is lowest in the sky. (Fig. 4). The first great spring increase follows the spring season of zenithal sun, and the summer maximum follows the summer period of zenithal sun. At some stations a short summer minimum follows the period when the sun is farthest to the north.

The wind roses (fig. 4) show, somewhat, the relationship between the winds of the ocean and the rainfall of the country. During the dry season all of the winds both near the shore and far out on the ocean are predominantly from a northeasterly direction. Most of them maintain velocities of 4 or 5 on the Beaufort scale. Since Salvador is on a southwest facing coast, these winter northeasterlies blow from the land toward the sea. During the wet season the two circles do not conform. The fall period of maximum rainfall seems to be emphasized by a general influx of upper air from over the ocean as indicated by the outermost circle of wind

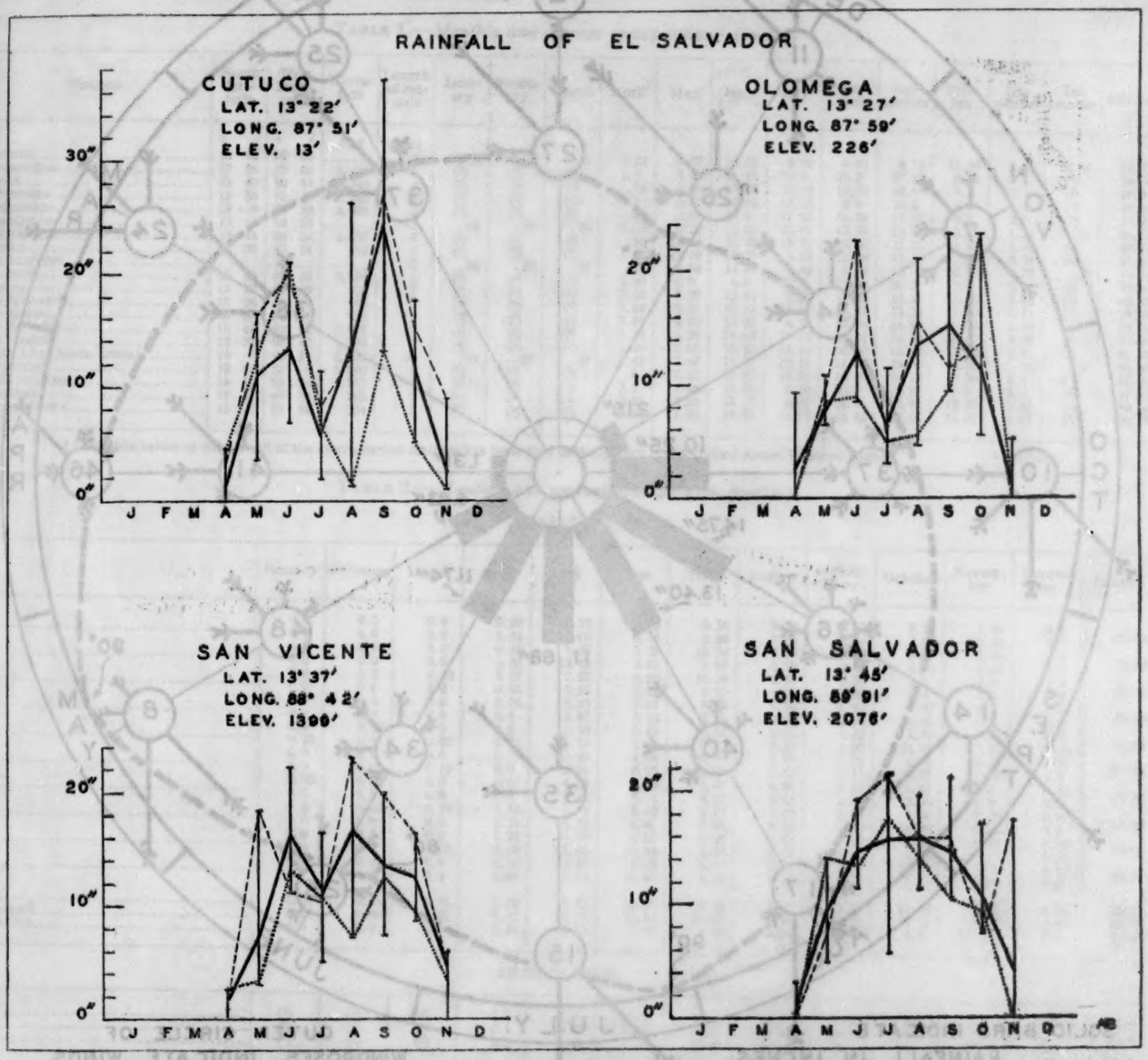

FIGURE 3.—The heavy black lines in these diagrams represent the average annual rainfall for the stations indicated. The dashlines represent the monthly rainfall for the years with the greatest annual total, while the dot-lines indicate the monthly rainfall for the years with the least annual total. The heavy vertical lines connect points representing the greatest absolute extremes of rainfall for each month during the 7-year period on record for each of these stations. The locations of these stations is indicated by dots on the relief map. Cutuco is farthest east, indicated by the dot on the bay. Olomega is next farther west followed in order by San Vicente and San Salvador

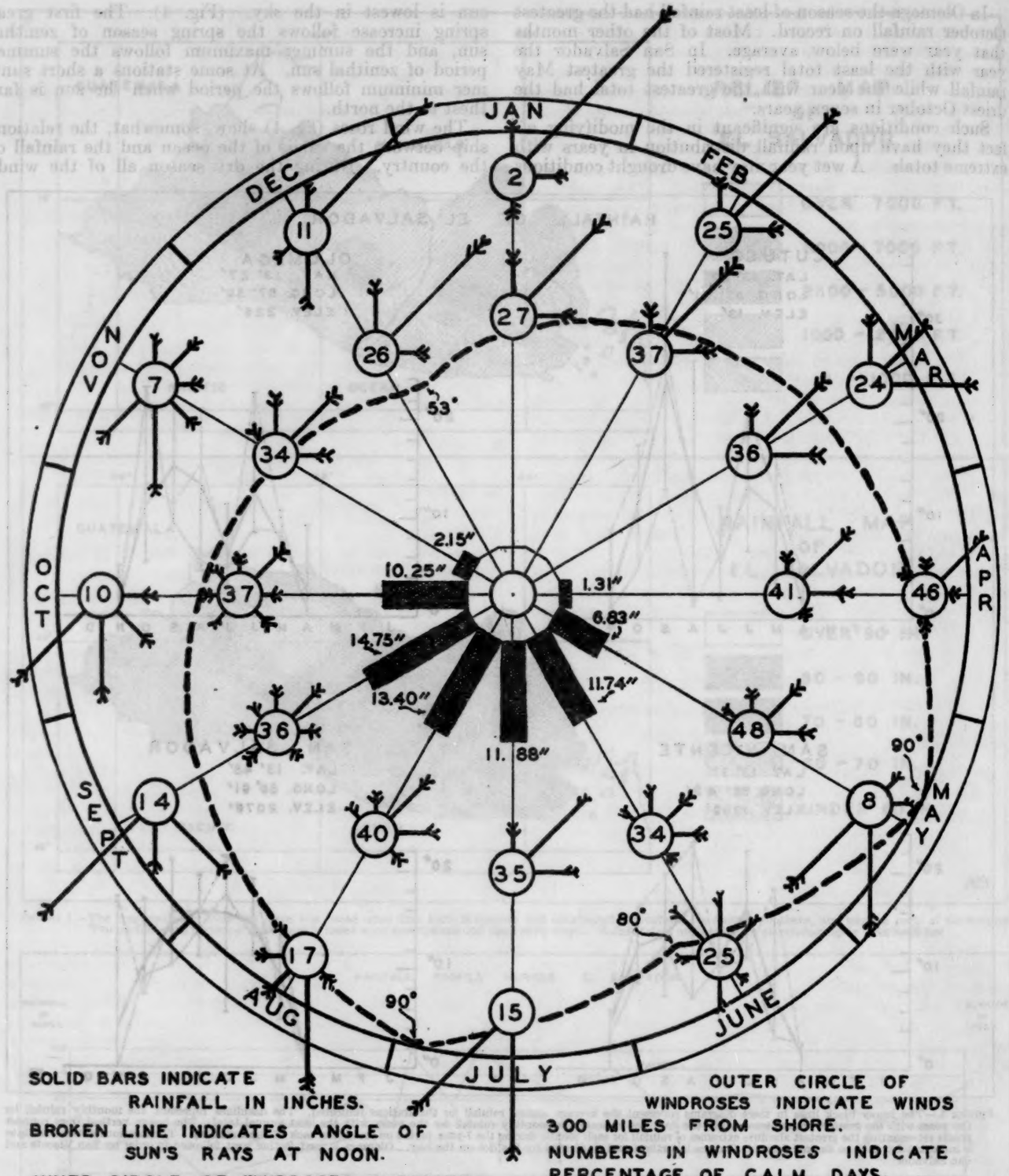

FIGURE 4.—The rainfall indicated in this chart is the average rainfall for all stations of the country. The line indicating the angular position of the sun is made as for the 13° 30′ parallel, and represents the attitude of the sun toward a point on that parallel at noon each day. The nearer the line approaches the circle the more nearly zenithal is the sun. The wind roses represent conditions only on the ocean. Those in the outer circle represent conditions about 300 miles out at sea, while those in the inner circle represent conditions about as near to shore as ships commonly travel. They are all based upon data taken from the United States Hydrographic Office Pilot Charts for the North Pacific Ocean for 1930

roses. The winds out on the ocean have turned about face and blow from the southwest and neighboring directions for several months with forces of 4 and 5, and with a comparatively low per cent of calm days. These winds do not continue as surface winds up to the shore. There the winds are variable with high per cents of calm, and with very infrequent south or southwesterly winds. It is evident that frequently strong southwest winds are blowing 300 miles out at sea while the shore region is in calm. At the same time the northeast winds may be found blowing across the Central American Cordilleras. These latter winds descending on the western side of the mountains tend to increase the speed of convection. Thus the moisture-laden air, brought near to the land by the strong winds starting far out on the ocean, rises and gives to the country of Salvador its bountiful rainfall in the form of heavy convectional summer rains.

TABLE 1.—*Monthly and average precipitation* [1] *(inches)*

Stations	North latitude	West longitude	Elevation	Length of records	January	February	March	April	May	June	July	August	September	October	November	December	Annual
	° ′	° ′	*Feet*	*years*													
Acajutla	13 40	89 55		10	0.03	0.02	0.13	3.22	8.87	12.58	9.99	9.61	9.15	11.06	1.05	0.46	66.17
Ahuachapan	13 54	89 51	2,470	3	(2)	(2)	(2)	1.1	6.33	14.73	10.9	13.2	17.55	8.05	3.2	(2)	75.06
Apopa	13 49	89 44	1,348	4	(2)	(2)	(2)	.33	7.86	11.26	12.96	13.63	10.6	8.1	2.1	(2)	66.84
Atiquizaya	13 58	89 47	2,051	1½	(2)	(2)	(2)	.1	5.85	9.95	10.15	6.9	16.4	8.7	1.9	(2)	59.95
Chalchuapa	13 58	89 42	2,305	3	(2)	(2)	(2)	.06	3.03	12.9	12.63	11.25	11.15	9.2	2.2	(2)	62.42
Coatepeque	13 55	89 30		11	.09	.00	.29	2.36	9.12	11.86	10.63	12.32	11.92	8.63	1.25	.10	68.57
Cojutepeque	13 44	88 53	2,627	7	(2)	(2)	(2)	.86	11.15	17.99	19.77	19.06	17.30	11.23	1.38	(2)	98.74
Cutuco	13 22	87 51	13	7	(2)	(2)	(2)	1.54	11.10	13.55	5.69	13.68	24.06	11.26	2.21	(2)	83.69
Horminguero				7	.00	.02	.73	.62	8.59	14.97	8.49	7.34	15.75	16.70	2.73	.00	75.94
Michapa	13 45	88 53	2,290	1	(2)	(2)	(2)	2.00	0.0	0.0	28.2	16.0	20.2	7.2	2.3	(2)	75.90
Olomega	13 27	87 59	226	7	(2)	(2)	(2)	2.02	7.90	12.81	6.15	13.65	15.21	11.03	1.18	(2)	69.95
San Marcos L	13 26	88 41	65	7	(2)	(2)	(2)	1.38	8.81	12.18	14.15	11.71	14.53	11.82	1.51	(2)	76.09
San Miguel	13 33	88 8	355	7	(2)	(2)	(2)	2.64	9.82	15.27	8.31	12.68	14.23	13.73	2.06	(2)	78.76
San Salvador	13 45	89 91	2,076	7	(2)	(2)	(2)	1.23	9.39	14.63	15.52	15.52	14.24	10.67	4.06	(2)	85.26
San Vicente	13 37	88 42	1,399	7	(2)	(2)	(2)	1.09	7.88	16.27	11.45	16.62	13.83	12.43	2.41	(2)	81.98
Santa Ana (Santa Lucia)	14 5	89 34	2,102	16	.12	.03	.10	1.44	7.47	11.97	10.18	11.09	12.36	8.26	.85	.18	65.93
Soyapango	13 45	89 8	2,040	5	(2)	(2)	(2)	.6	7.52	19.37	14.60	12.40	24.40	16.39	3.0	(2)	98.28
Texiz Junction	14 13	89 33	1,317	3	(2)	(2)	(2)	2.2	1.66	12.36	6.96	10.5	10.95	1.5	2.2	(2)	48.33
Usulutan	13 21	88 25	235	7	(2)	(2)	(2)	2.53	8.14	13.27	9.81	14.74	16.86	12.39	2.62	(2)	80.36
Zacatecoluca	13 27	88 49	564	7	(2)	(2)	(2)	1.28	7.92	16.05	12.77	18.82	18.87	13.81	1.07	(2)	90.59

[1] Complete tables of data for all of the above-named stations has been filed in the library of the United States Weather Bureau

[2] No data.

TABLE 2.—*Monthly and annual precipitation (inches)*

ACAJUTLA [1]

	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1914	0.0	0.0	0.0	0.26	2.26	9.25	5.18	3.28	5.53	3.19	1.69	0.0	60.62
	0.0	0.0	0.0	1.41	2.66	6.75	2.82	3.26	5.85	7.07	0.16	0.0	
1915	0.0	0.0	0.0	0.10	3.20	5.25	10.55	0.50	6.50	3.3	2.40	0.0	71.80
	0.0	0.0	0.0	1.20	12.58	5.65	3.87	6.70	5.50	4.00	0.50	0.0	
1916	0.0	0.0	0.10	0.37	7.07	6.20	10.20	4.40	2.00	0.0	0.0	0.0	58.20
	0.0	0.0	0.0	0.45	0.62	7.27	9.20	6.23	5.09	0.0	0.0	0.0	
1917	0.0	0.0	0.0	0.25	2.97	7.41	8.49	8.23	3.99	5.99	0.0	0.0	59.18
	0.0	0.0	0.0	0.0	3.87	5.22	3.42	4.15	2.36	2.83	0.0	0.0	
1918	0.0	0.10	0.0	0.0	3.28	5.42	4.63	5.41	4.62	3.58	0.0	0.0	70.50
	0.20	0.0	0.67	9.21	5.73	2.21	3.77	3.16	1.99	11.18	1.34	4.00	
1919	0.0	0.0	0.0	0.77	4.02	4.18	10.74	2.75	7.34	1.15	0.47	0.05	64.21
	0.0	0.0	0.15	0.0	2.91	6.25	2.97	5.52	7.37	7.37	0.20	0.0	
1920	0.06	0.0	0.0	0.07	4.13	0.80	3.07	8.65	4.41	4.37	0.0	0.36	51.56
	0.0	0.0	0.0	0.0	5.10	8.14	4.53	2.62	1.95	3.30	0.0	0.0	
1921	0.0	0.04	0.26	5.55	3.75	9.32	0.77	8.65	2.88	5.18	0.20	0.0	85.09
	0.0	0.0	0.0	2.70	6.57	6.97	3.05	2.62	7.39	18.96	0.23	0.0	
1922	0.0	0.0	0.0	7.25	5.70	9.80	1.19	6.81	7.69	4.19	0.10	0.05	74.17
	0.0	0.0	0.15	2.52	1.95	1.88	2.35	9.72	1.85	7.74	3.15	0.08	
1923	0.0	0.02	0.0	0.06	4.18	3.18	4.77	2.22	3.40	12.05	0.05	0.02	65.29
	0.0	0.0	0.0	0.07	6.14	14.67	4.30	1.25	3.80	5.11	0.0	0.0	
Mean	0.03	0.02	0.13	3.22	8.87	12.58	9.99	9.61	9.15	11.06	1.05	0.46	66.17
Maximum	0.21	0.10	0.67	9.21	15.78	17.85	19.40	16.53	14.71	24.14	3.25	4.00	85.09
Minimum	0.0	0.0	0.0	0.07	4.92	7.63	3.54	3.54	6.20	0.0	0.0	0.0	51.56

AHUACHAPAN

1928	(2)	(2)	(2)	1.8	3.5	16.6	10.1	14.5	10.2	6.1	3.0	(2)	65.8
1929	(2)	(2)	(2)	0.4	9.3	11.9	12.2	11.9	24.9	10.0	3.4	(2)	84.0
1930	(2)	(2)	(2)	1.1	6.2	15.7	10.4	(2)	(2)	(2)	(2)	(2)	(2)
Mean	(2)	(2)	(2)	1.1	6.33	14.73	10.9	13.2	17.55	8.05	3.2	(2)	75.06
Maximum	(2)	(2)	(2)	1.8	9.3	16.6	12.2	14.5	24.9	10.0	3.4	(2)	84.0
Minimum	(2)	(2)	(2)	0.4	3.5	11.9	10.1	11.9	10.2	6.1	3.0	(2)	65.8

APOPA

1927	(2)	(2)	(2)	(2)	(2)	(2)	(2)	10.1	2.6	3.9	0.0	(2)	(2)
1928	(2)	(2)	(2)	0.0	7.2	15.1	14.3	14.6	13.1	8.5	4.9	(2)	77.7
1929	(2)	(2)	(2)	0.0	11.5	7.4	14.5	16.2	16.1	11.9	1.4	(2)	79.0
1930	(2)	(2)	(2)	1.0	4.9	11.3	10.1	(2)	(2)	(2)	(2)	(2)	(2)
Mean	(2)	(2)	(2)	0.33	7.86	11.26	12.96	13.63	10.6	8.1	2.1	(2)	66.84
Maximum	(2)	(2)	(2)	1.0	11.5	15.1	14.5	16.2	16.1	11.9	4.9	(2)	79.0
Minimum	(2)	(2)	(2)	0.0	4.9	7.4	10.1	10.1	2.6	3.9	1.4	(2)	77.7

[1] Data given by half month periods.

[2] No data.

TABLE 2.—*Monthly and annual precipitation (inches)*—Continued

ATIQUIZAYA

	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1929	(1)	(1)	(1)	0.2	7.4	7.6	11.6	6.9	16.4	8.7	1.9	(1)	60.7
1930	(1)	(1)	(1)	0.0	4.3	12.3	8.7	(1)	(1)	(1)	(1)	(1)	(1)
Mean	(1)	(1)	(1)	0.1	5.85	9.95	10.1	(1)	(1)	(1)	(1)	(1)	(1)
Maximum	(1)	(1)	(1)	0.2	7.4	12.3	11.6	(1)	(1)	(1)	(1)	(1)	(1)
Minimum	(1)	(1)	(1)	0.0	4.3	7.6	8.7	(1)	(1)	(1)	(1)	(1)	(1)

CHALCHAUAPA

1928	(1)	(1)	(1)	0.0	0.0	4.9	21.6	14.1	8.5	9.0	2.9	(1)	61.0
1929	(1)	(1)	(1)	0.2	2.0	17.3	9.2	8.4	13.8	9.4	1.5	(1)	61.8
1930	(1)	(1)	(1)	0.0	7.1	16.7	7.1	(1)	(1)	(1)	(1)	(1)	(1)
Mean	(1)	(1)	(1)	0.06	3.03	12.9	12.63	11.25	11.15	9.2	2.2	(1)	62.42
Maximum	(1)	(1)	(1)	0.2	7.1	17.3	21.6	14.1	13.8	9.4	2.9	(1)	61.8
Minimum	(1)	(1)	(1)	0.0	0.0	4.9	7.1	8.4	8.5	9.0	1.5	(1)	61.0

COATEPEQUE [1]

1913	(1)	(1)	(1)	(1)	(1)	4.34	4.88	8.68	4.25	1.61	0.0	0.0	(1)
	(1)	(1)	(1)	(1)	(1)	9.80	6.61	6.86	5.97	7.34	0.0	0.0	(1)
1914	0.0	0.0	0.0	3.31	4.74	7.15	8.72	3.10	6.05	8.02	4.04	0.0	84.4
	0.0	0.0	0.0	0.72	8.79	7.78	5.93	4.80	6.53	4.70	0.02	0.0	
1915	0.0	0.0	0.0	0.44	3.01	5.69	8.94	6.34	6.93	3.31	1.29	0.31	75.37
	0.0	0.0	0.32	0.95	11.22	6.59	3.67	9.17	5.84	0.83	0.0	0.52	
1916	0.12	0.0	0.0	0.31	6.04	2.95	2.54	4.04	2.92	5.43	0.06	0.03	62.81
	0.83	0.0	0.0	1.54	3.11	7.26	5.71	9.83	9.31	0.47	0.31	0.0	
1917	0.0	0.0	0.0	1.03	1.85	2.60	5.57	10.08	5.20	0.32	0.32	0.0	69.75
	0.0	0.0	1.0	0.0	2.40	6.61	8.35	6.88	5.41	6.13	0.0	0.0	
1918	0.0	0.0	0.0	0.0	5.24	8.50	5.16	5.57	4.65	2.24	0.0	0.0	70.75
	0.0	0.0	0.0	7.99	6.49	6.54	3.00	3.90	6.95	4.52	0.0	0.0	
1919	0.0	0.0	0.0	0.02	5.09	2.82	10.17	1.72	3.27	3.24	1.55	0.0	53.40
	0.0	0.0	0.0	0.25	1.51	5.30	4.69	4.57	6.54	2.66	0.0	0.0	
1920	0.0	0.0	0.0	0.0	5.63	2.35	7.56	12.57	10.20	1.57	3.59	0.10	74.54
	0.0	0.0	0.0	0.58	7.22	8.50	6.33	3.97	2.08	2.29	0.0	0.0	
1921	0.0	0.0	1.15	3.71	2.07	5.21	4.14	5.68	4.77	5.27	0.0	0.0	82.69
	0.0	0.0	0.46	0.0	6.14	9.92	4.82	3.93	10.22	14.50	0.70	0.0	
1922	0.0	0.0	0.0	0.95	2.55	11.93	3.87	2.80	5.67	4.04	0.16	0.0	60.28
	0.0	0.0	0.0	1.85	2.38	3.54	3.19	8.67	6.39	1.83	0.46	0.0	
1923	0.0	0.0	0.0	0.0	2.69	3.84	3.12	(1)	(1)	(1)	(1)	(1)	(1)
	0.0	0.0	0.26	0.0	3.05	1.27	(1)	(1)	(1)	(1)	(1)	(1)	
Mean	0.09	0.0	0.29	2.36	9.12	11.86	10.63	12.32	11.92	8.63	1.25	0.10	68.57
Maximum	0.95	0.0	1.61	7.99	14.23	15.47	14.86	16.96	14.99	19.77	4.06	0.83	84.40
Minimum	0.0	0.0	0.0	0.0	4.25	5.11	7.06	6.29	9.81	3.86	0.0	0.0	53.40

COJUTEPEQUE

1924	(1)	(1)	(1)	(1)	8.90	15.50	12.00	17.50	14.20	10.70	0.0	0.0	(1)
1925	(1)	(1)	(1)	2.30	4.20	9.30	15.80	9.30	9.35	10.20	3.70	0.0	64.15
1926	(1)	(1)	(1)	0.0	8.35	11.95	9.80	14.40	14.46	7.81	0.40	0.0	67.17
1927	(1)	(1)	(1)	0.0	13.10	14.30	19.50	11.40	12.70	14.70	0.0	0.0	85.70
1928	(1)	(1)	(1)	1.70	5.90	48.40	44.70	18.40	26.10	6.10	4.20	0.0	155.50
1929	(1)	(1)	(1)	0.0	7.80	16.00	24.00	43.40	27.00	17.90	0.0	0.0	136.10
1930	(1)	(1)	(1)	1.20	29.80	10.50	12.60	(1)	(1)	(1)	(1)	(1)	(1)
Mean	(1)	(1)	(1)	.86	11.15	17.99	19.77	19.06	17.30	11.23	1.38	0.0	98.74
Maximum	(1)	(1)	(1)	2.30	29.80	48.40	44.70	43.40	27.00	17.90	4.20	0.0	155.50
Minimum	(1)	(1)	(1)	0.0	4.20	9.30	9.80	9.30	9.35	6.10	0.0	0.0	64.15

CUTUCO

1924	(1)	(1)	(1)	0.76	2.78	17.17	11.45	13.77	12.25	9.60	0.0	0.0	(1)
1925	(1)	(1)	(1)	4.23	12.35	20.25	6.58	1.89	13.34	5.06	1.0	0.0	64.70
1926	(1)	(1)	(1)	0.0	9.40	11.05	4.50	16.80	37.10	13.60	0.0	0.0	92.45
1927	(1)	(1)	(1)	0.0	12.20	8.00	4.00	11.20	33.10	6.90	0.0	0.0	75.40
1928	(1)	(1)	(1)	3.80	16.80	20.00	8.40	12.70	27.00	15.30	8.8	0.0	112.80
1929	(1)	(1)	(1)	0.0	15.70	6.80	3.00	26.40	21.60	17.10	3.5	0.0	94.10
1930	(1)	(1)	(1)	0.5	12.70	11.60	1.90	(1)	(1)	(1)	(1)	(1)	(1)
Mean	(1)	(1)	(1)	1.54	11.10	13.55	5.69	13.68	24.06	11.26	2.21	0.0	83.69
Maximum	(1)	(1)	(1)	4.23	16.80	20.25	11.45	26.40	37.10	17.10	8.80	0.0	112.80
Minimum	(1)	(1)	(1)	0.0	2.78	6.80	1.90	1.89	12.25	5.06	0.0	0.0	64.70

HORMINGUERO

1917	0.0	0.0	0.0	0.0	3.30	8.58	10.33	13.70	15.57	25.21	0.59	0.0	77.30
1918	0.0	0.0	2.97	3.34	10.31	21.33	7.22	7.40	10.94	15.44	1.50	0.0	80.45
1919	0.0	0.0	0.0	0.70	9.92	8.41	11.80	6.46	16.24	10.13	2.63	0.0	66.27
1920	0.0	0.0	0.0	0.28	7.84	10.81	2.28	7.36	16.78	10.23	11.94	0.0	67.52
1921	0.0	0.15	0.82	0.0	8.14	24.10	9.70	7.47	18.33	21.68	2.23	0.0	92.62
1922	0.0	0.0	0.0	0.0	16.61	17.61	7.67	6.23	15.95	23.76	0.22	0.0	89.44
1923	0.0	0.0	1.35	0.04	3.98	13.98	10.46	2.78	16.44	10.42	0.0	0.0	58.05
Mean	0.0	0.02	0.73	0.62	8.59	14.97	8.49	7.34	15.75	16.70	2.73	0.0	75.94
Maximum	0.0	0.15	2.97	3.34	16.61	24.10	11.80	13.70	18.33	25.21	11.94	0.0	92.62
Minimum	0.0	0.0	0.0	0.0	3.30	8.41	2.28	2.78	10.94	10.13	0.0	0.0	58.05

[1] Data given by half month periods.

[1] No data.

TABLE 2.—*Monthly and annual precipitation (inches)*—Continued

MICHAPA

	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1928	[2]	[2]	[2]	2.00	0.0	0.0	0.0	16.0	20.2	7.2	2.3	0.0	75.90

OLOMEGA

1924	[2]	[2]	[2]	[2]	[2]	14.60	11.70	18.10	16.77	5.90	0.0	[2]	[2]
1925	[2]	[2]	[2]	9.10	7.10	13.90	5.50	4.30	13.60	6.70	4.60	[2]	64.80
1926	[2]	[2]	[2]	0.0	4.90	12.10	5.50	21.30	15.60	10.20	1.00	[2]	70.60
1927	[2]	[2]	[2]	0.0	9.70	22.50	5.90	15.80	11.70	13.90	0.0	[2]	79.50
1928	[2]	[2]	[2]	1.00	10.90	9.80	6.50	16.70	23.80	5.70	0.0	[2]	74.40
1929	[2]	[2]	[2]	0.0	8.20	8.60	5.00	5.70	9.80	23.80	1.50	[2]	62.60
1930	[2]	[2]	[2]	0.0	6.60	8.20	3.00	[2]	[2]	[2]	[2]	[2]	[2]
Mean	[2]	[2]	[2]	2.20	7.90	12.81	6.15	13.65	15.21	11.03	1.18	[2]	69.95
Maximum	[2]	[2]	[2]	9.10	10.90	22.50	11.70	21.30	23.80	23.80	4.60	[2]	79.50
Minimum	[2]	[2]	[2]	0.0	4.90	8.20	3.00	4.30	9.80	5.70	0.0	[2]	62.60

SAN MARCOS L.

1924	[2]	[2]	[2]	[2]	6.30	18.80	21.00	17.71	13.20	4.70	0.0	[2]	[2]
1925	[2]	[2]	[2]	6.20	6.30	11.20	7.95	3.10	15.01	7.86	3.31	[2]	60.93
1926	[2]	[2]	[2]	0.0	9.70	7.40	9.80	12.10	4.60	2.80	0.0	[2]	46.40
1927	[2]	[2]	[2]	0.0	9.90	12.70	15.30	26.0	17.0	25.50	0.0	[2]	106.40
1928	[2]	[2]	[2]	2.10	4.80	21.60	30.80	0.0	20.20	8.60	4.80	[2]	92.90
1929	[2]	[2]	[2]	0.0	11.50	3.80	11.00	11.40	17.20	21.50	1.00	[2]	77.40
1930	[2]	[2]	[2]	0.0	13.20	9.70	3.20	[2]	[2]	[2]	[2]	[2]	[2]
Mean	[2]	[2]	[2]	1.38	8.81	12.18	14.15	11.71	14.53	11.82	1.51	[2]	76.09
Maximum	[2]	[2]	[2]	6.20	13.20	21.60	30.80	26.00	20.20	25.50	4.80	[2]	106.40
Minimum	[2]	[2]	[2]	0.0	4.80	3.80	3.20	0.0	4.60	4.70	0.0	[2]	46.40

SAN MIGUEL

1924	[2]	[2]	[2]	[2]	4.66	13.90	19.60	23.20	13.30	9.80	0.0	[2]	[2]
1925	[2]	[2]	[2]	11.40	4.50	12.10	4.20	3.60	20.70	15.00	3.20	[2]	74.70
1926	[2]	[2]	[2]	0.0	12.88	18.00	5.30	12.80	8.80	11.10	0.80	[2]	69.68
1927	[2]	[2]	[2]	0.0	11.10	20.30	5.20	13.60	13.30	21.00	0.0	[2]	84.50
1928	[2]	[2]	[2]	0.30	15.10	16.10	12.10	11.20	15.90	6.10	6.70	[2]	83.50
1929	[2]	[2]	[2]	0.0	16.70	17.50	9.20	11.70	13.40	19.40	1.80	[2]	89.70
1930	[2]	[2]	[2]	1.50	3.80	9.00	2.60	[2]	[2]	[2]	[2]	[2]	[2]
Mean	[2]	[2]	[2]	2.64	9.82	15.27	8.31	12.68	14.23	13.73	2.08	[2]	78.76
Maximum	[2]	[2]	[2]	11.40	16.70	20.30	19.60	23.20	20.70	21.00	6.70	[2]	89.70
Minimum	[2]	[2]	[2]	0.0	3.80	9.00	2.60	3.60	8.80	6.10	0.0	[2]	69.68

SAN SALVADOR

1924	[2]	[2]	[2]	[2]	4.82	16.35	19.00	18.91	13.05	9.30	0.0	[2]	[2]
1925	[2]	[2]	[2]	3.00	6.70	12.82	17.53	13.40	13.71	13.02	3.20	[2]	83.38
1926	[2]	[2]	[2]	1.90	7.20	18.45	11.90	19.45	11.97	8.10	1.30	[2]	80.27
1927	[2]	[2]	[2]	0.0	14.00	13.10	17.50	14.00	10.30	9.50	0.0	[2]	78.40
1928	[2]	[2]	[2]	0.20	7.30	19.00	21.20	15.70	15.60	7.40	17.50	[2]	103.90
1929	[2]	[2]	[2]	0.0	5.00	11.40	15.60	11.70	20.80	16.70	2.40	[2]	83.60
1930	[2]	[2]	[2]	2.30	6.70	11.30	5.90	[2]	[2]	[2]	[2]	[2]	[2]
Mean	[2]	[2]	[2]	1.23	9.39	14.63	15.52	15.50	14.24	10.67	4.06	[2]	85.25
Maximum	[2]	[2]	[2]	3.00	14.00	19.00	21.20	19.45	20.80	16.70	17.50	[2]	103.90
Minimum	[2]	[2]	[2]	0.0	4.82	11.30	5.90	11.70	10.30	7.40	0.0	[2]	78.40

SAN VICENTE

1924	[2]	[2]	[2]	[2]	3.00	22.05	16.45	17.10	14.75	12.40	0.0	[2]	[2]
1925	[2]	[2]	[2]	2.66	3.47	13.05	10.62	7.13	12.57	9.25	3.85	[2]	62.60
1926	[2]	[2]	[2]	0.0	5.19	10.13	12.69	20.60	10.80	9.00	0.0	[2]	68.41
1927	[2]	[2]	[2]	0.0	11.90	21.20	16.50	13.70	7.30	14.80	0.0	[2]	85.40
1928	[2]	[2]	[2]	1.30	6.30	21.00	5.20	18.30	17.70	13.00	6.00	[2]	88.80
1929	[2]	[2]	[2]	0.30	18.10	11.30	10.20	22.90	19.90	16.10	4.60	[2]	103.40
1930	[2]	[2]	[2]	2.30	7.20	15.2	8.50	[2]	[2]	[2]	[2]	[2]	[2]
Mean	[2]	[2]	[2]	1.09	7.88	16.27	11.45	16.62	13.83	12.43	2.41	[2]	81.98
Maximum	[2]	[2]	[2]	2.66	18.10	22.05	16.50	22.90	19.90	16.10	6.00	[2]	103.40
Minimum	[2]	[2]	[2]	0.0	3.00	10.13	5.20	7.13	7.30	9.00	0.0	[2]	62.60

SANTA ANA [3]

1912	[2]	[2]	[2]	[2]	1.06	1.91	3.90	2.51	6.38	3.50	0.10	0.83	[2]
	[2]	[2]	[2]	0.09	4.28	2.60	4.95	5.33	5.68	2.13	0.0	0.0	
1913	0.0	0.0	0.0	1.03	1.21	5.09	6.13	3.75	5.61	2.44	0.0	0.0	60.80
	0.0	0.0	0.0	0.86	10.65	5.25	6.43	3.14	2.99	6.22	0.0	0.0	
1914	0.0	0.0	0.0	0.12	2.56	5.84	4.05	1.58	10.29	3.99	0.47	0.0	60.87
	0.0	0.0	0.0	1.26	7.59	6.32	1.77	7.23	5.48	2.32	0.0	0.0	
1915	0.0	0.0	0.0	1.08	2.46	8.18	10.62	7.95	7.81	3.53	0.42	0.42	79.49
	0.0	0.0	0.27	0.0	6.89	5.52	10.00	8.02	5.30	0.45	0.46	0.11	
1916	0.0	0.0	0.0	0.17	8.36	1.62	3.50	5.61	2.82	3.74	0.13	0.04	60.70
	0.80	0.0	0.0	7.06	4.73	6.87	7.88	3.97	8.72	2.83	0.85	0.0	
1917	0.0	0.05	0.0	0.28	1.65	5.51	4.95	9.15	4.99	5.14	0.55	0.0	64.23
	0.0	0.26	0.0	0.03	2.34	8.77	4.75	5.21	7.32	3.28	0.0	0.0	
1918	0.0	0.0	0.0	0.0	3.55	7.37	2.63	7.96	3.11	4.37	0.0	0.0	67.06
	0.33	0.0	0.0	3.99	3.83	6.83	4.83	4.52	7.69	6.05	0.0	0.0	
1919	0.04	0.0	0.0	0.14	4.86	5.95	7.96	2.12	2.02	6.54	1.38	0.0	56.97
	0.0	0.0	0.0	0.66	1.12	7.09	3.43	5.73	6.05	1.87	0.0	0.0	
1920	0.0	0.0	0.0	0.0	3.14	3.18	3.88	11.14	12.41	2.77	1.45	0.0	65.9
	0.0	0.0	0.0	0.0	6.34	9.06	4.15	3.97	2.06	2.41	0.0	0.0	

[2] No data.

[3] 1920 to 1923 data given by half month periods.

TABLE 2.—*Monthly and annual precipitation (inches)*—Continued

SANTA ANA—Continued

	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1921	0.0	0.0	0.70	0.0	0.80	9.37	3.03	9.54	6.55	7.09	0.0	0.71	85.83
	0.0	0.0	0.0	0.0	3.12	8.55	3.76	4.11	12.91	14.65	0.92	0.0	
1922	0.0	0.0	0.0	[1]	0.0	13.20	3.96	7.45	8.32	4.39	1.22	0.0	[1]
	0.0	0.0	0.0	[1]	5.57	4.22	4.42	13.08	7.65	1.27	1.51	0.0	[1]
1923	[1]	[1]	[1]	[1]	[1]	[1]	[1]	[1]	1.70	7.52	0.0	0.0	[1]
	[1]	[1]	[1]	[1]	[1]	[1]	[1]	0.57	3.85	0.75	0.0	0.0	[1]
1927	[1]	[1]	[1]	[1]	15.50	13.50	16.20	9.40	14.40	6.30	0.0	[1]	75.3
1928	[1]	[1]	[1]	0.70	11.30	15.50	11.40	14.00	10.40	6.20	3.30	[1]	73.90
1929	[1]	[1]	[1]	1.70	8.20	10.00	12.60	9.30	15.00	12.20	0.0	[1]	69.60
1930	[1]	[1]	[1]	4.00	8.40	13.20	11.80	[1]	[1]	[1]	[1]	[1]	[1]
Mean	0.12	0.03	0.10	1.44	7.47	11.97	10.18	11.09	12.36	8.26	0.85	0.18	65.93
Maximum	0.80	0.26	0.70	7.23	15.50	17.92	20.62	20.53	19.46	21.74	3.30	0.83	85.83
Minimum	0.0	0.0	0.0	0.0	3.92	4.51	5.82	6.89	5.55	3.98	0.0	0.0	60.80

SOYAPANGO

1926	[1]	[1]	[1]	[1]	[1]	[1]	[1]	[1]	17.50	8.90	0.70	[1]	[1]
1927	[1]	[1]	[1]	0.0	0.0	23.20	20.00	24.30	21.90	27.50	0.0	[1]	116.90
1928	[1]	[1]	[1]	0.50	8.50	25.10	19.70	0.0	38.60	16.80	6.30	[1]	115.50
1929	[1]	[1]	[1]	0.0	7.00	13.90	12.60	12.90	19.60	13.10	5.10	[1]	84.20
1930	[1]	[1]	[1]	1.30	7.10	11.30	6.10	[1]	[1]	[1]	[1]	[1]	[1]
Mean	[1]	[1]	[1]	0.60	7.52	19.37	14.60	12.40	24.40	16.39	3.00	[1]	95.28
Maximum	[1]	[1]	[1]	1.30	8.50	25.10	20.00	24.30	38.60	27.50	6.30	[1]	116.90
Minimum	[1]	[1]	[1]	0.0	0.0	11.30	6.10	0.0	17.50	8.90	0.0	[1]	84.20

TEXIZ JUNCTION

1928	[1]	[1]	[1]	3.40	0.0	18.0	9.30	17.50	7.40	0.0	4.40	[1]	60.00
1929	[1]	[1]	[1]	3.20	3.40	11.40	5.30	3.50	14.50	3.00	0.0	[1]	44.30
1930	[1]	[1]	[1]	0.0	1.60	7.70	6.30	[1]	[1]	[1]	[1]	[1]	[1]
Mean	[1]	[1]	[1]	2.20	1.66	12.76	6.96	10.50	10.95	1.50	2.20	[1]	48.33
Maximum	[1]	[1]	[1]	3.40	3.40	18.00	9.30	17.50	14.50	3.00	4.40	[1]	60.00
Minimum	[1]	[1]	[1]	0.0	0.0	7.70	5.30	3.50	7.40	0.0	0.0	[1]	44.30

USULUTAN

1924	[1]	[1]	[1]	[1]	0.83	19.97	17.01	18.56	14.04	8.35	0.0	[1]	[1]
1925	[1]	[1]	[1]	10.98	5.05	8.14	9.26	6.19	21.03	13.15	4.05	[1]	77.85
1926	[1]	[1]	[1]	0.0	3.30	13.70	9.03	22.20	21.70	14.06	0.40	[1]	84.39
1927	[1]	[1]	[1]	0.0	23.50	22.20	12.20	16.90	12.60	12.10	0.0	[1]	99.50
1928	[1]	[1]	[1]	0.60	8.60	15.40	6.30	14.10	17.00	5.40	7.20	[1]	74.60
1929	[1]	[1]	[1]	1.10	9.60	9.30	9.70	10.50	14.80	21.30	2.30	[1]	78.60
1930	[1]	[1]	[1]	0.0	6.10	4.20	5.20	[1]	[1]	[1]	[1]	[1]	[1]
Mean	[1]	[1]	[1]	2.53	8.14	13.27	9.81	14.74	16.86	12.39	2.62	[1]	80.36
Maximum	[1]	[1]	[1]	10.98	23.50	22.20	17.01	22.20	21.70	21.30	7.20	[1]	99.50
Minimum	[1]	[1]	[1]	0.0	0.83	4.20	5.20	6.19	12.60	5.40	0.0	[1]	74.60

ZACATECOLUCA

1924	[1]	[1]	[1]	[1]	2.70	19.70	23.20	17.70	20.50	15.98	0.0	[1]	[1]
1925	[1]	[1]	[1]	3.28	8.71	11.68	13.42	9.37	9.79	9.74	2.97	[1]	68.96
1926	[1]	[1]	[1]	0.0	7.09	14.42	15.27	25.86	19.77	17.55	0.0	[1]	99.96
1927	[1]	[1]	[1]	0.0	13.60	12.80	4.80	26.80	13.40	11.90	0.0	[1]	83.30
1928	[1]	[1]	[1]	2.00	10.20	19.30	13.40	17.70	26.20	9.10	3.50	[1]	101.40
1929	[1]	[1]	[1]	0.0	10.00	19.30	11.60	15.50	23.60	18.60	0.0	[1]	98.60
1930	[1]	[1]	[1]	2.40	3.20	15.20	7.70	[1]	[1]	[1]	[1]	[1]	[1]
Mean	[1]	[1]	[1]	1.28	7.92	16.05	12.77	18.82	18.87	13.81	1.07	[1]	90.59
Maximum	[1]	[1]	[1]	3.28	13.60	19.70	23.20	26.80	26.20	18.60	3.50	[1]	101.40
Minimum	[1]	[1]	[1]	0.0	2.70	11.68	4.80	9.37	9.79	9.10	0.0	[1]	68.96

[1] No data.

NOTES, ABSTRACTS, AND REVIEWS

Glaze storm in South Dakota, November 18 to 20, 1930, by M. E. Blystone.—The glaze storm of November 19 to 20, 1930, extended from Charles Mix and Gregory Counties, S. Dak., northward to Edmunds County, and from Edmunds, Faulk, and northern Hand Counties eastward to the border of the State. It occurred during the passage of a cyclone of great intensity from Texas northeastward across the western slope of the Mississippi Basin. Within the area indicated the temperature was near, or slightly below, the freezing point, and the precipitation occurred mostly in the form of rain. The rain froze on electric wires, trees, etc., forming cylinders of ice which, in many instances, are reported to have been an inch or more in diameter. The weight of the ice, together with the rather high wind that attended the storm, caused wires and large numbers of poles to be broken down. Trees, also, were broken down, but the main damage was to electric lines. The damage from this storm is estimated to be from $400,000 to $500,000. It is generally believed that this was the most destructive glaze storm in the history of South Dakota. However, the great increase in the mileage of electric lines in recent years has greatly increased the possibilities of destruction by such a storm.

The width of the zone within which the glaze storm occurred is from 30 to 60 miles. To the north and west of this zone the precipitation was in the form of snow. While to the south and east of the two wings of the glaze

storm area the precipitation was in the form of rain, the temperature there was not low enough to cause the rain to freeze on the surfaces on which it fell.

The glaze storm of November 15 to 16, 1930, in North Dakota and Minnesota, by R. J. McClurg.—On Friday evening November 14, 1930 at 7:09 p. m. a fine misting rain began to fall in the Fargo-Moorhead area. This mist continued throughout Friday night, Saturday, and a portion of Saturday night. A very light north and northwest wind accompanied it. The temperature fell to 31° about 9 a. m. Saturday causing the rain to freeze as it came in contact with any object, except the sidewalks and paved streets. It formed glaze on the ground, trees, telegraph and telephone wires, and on buildings. Early Sunday morning the mist turned to a moderate rain continuing until 5:40 p. m., when it turned to sleet until 5:46 p. m., then turning to snow. The glaze kept increasing throughout Saturday night and Sunday forenoon.

At 12 noon Sunday ordinary uninsulated telephone wires were coated with glaze from one-half to five-eighths inch in diameter. The ice was much thicker on the top and north side of the wires. Icicles from 3 to 4 inches long hung from the wires, with 8 or 9 icicles per foot. On Monday, November 17, when the sun broke through the clouds, the entire landscape presented a glittering aspect. The trees were especially beautiful with every twig covered with ice and sparkling in the sunlight.

It seems incongruous that a storm could produce so much beauty, and yet be so destructive. It was estimated that a main toll line of 60 wires in Moorhead carried a weight of over 2 tons of ice from pole to pole, a distance of 132 feet. From reliable reports this storm was confined mostly to the Red River Valley north of Moorhead, covering an area of about 40 miles in width and 100 miles in length.

The toll line mentioned in the above paragraph was a complete loss for one-half mile, due to the breaking of the poles under the great strain. The Northwestern Bell Telephone Co. estimate their loss at $40,000; this does not include loss of revenue. The Western Union Telegraph Co. estimate their loss to the communication lines at $5,000; the loss of revenue not estimated. The Great Northern Railway Co. estimate their loss at $2,000, and the Northern Pacific Railway Co. estimate their loss at $1,500. The damage to the Moorhead municipal light and power lines was estimated at $100 by the breaking of several poles and wires. The damage to trees in this area can not be estimated, but undoubtedly it will be great, because in so many places branches up to 4 inches in diameter were snapped off under the weight of the ice.

The absence of strong winds with the unusually low barometric pressure during this storm lessened the loss immensely. A storm of this nature is very unusual for this section of the country, so is of great interest from a meteorological viewpoint.

The glaze storm of the 19th and 20th which occurred west and south of this station caused greater damage than the one above-described; at this writing (November 24) communication lines are still out of order.

Note on the effect of a lightning bolt (by *A. G. Simson*).—The effect of a lightning bolt striking an air-tight cylinder may be of interest to some of the students of lightning behavior. The cylinder, which was of about 18-gage nickel-plated brass, measured 4 by 22 centimeters, had been partially buried in the scanty soil on the topmost pinnacle of Three Fingered Jack, a mountain peak in central Oregon. It lay in approximately the position shown in Figure 1. The tube had been placed there as a receptacle for the register of the names of a party of hardy souls who had scaled that difficult peak.

Assuming, in order to simplify the explanation, that the lightning was from cloud to earth, it appears that the bolt entered the tube at the point A, burning a hole 6 by 18 millimeters, having an area of approximately 105 square millimeters. Three points of exit are indicated, B, C, and D. B is a large oval hole 14 by 21 millimeters, of area 240 square millimeters, and C and D are blisters 5 millimeters in diameter on the surface of the metal. (See fig. 1.) There were no evidences of pressure, internal or external, against the walls of the cylinder. Unfortunately there is no information available as to whether or not the lightning destroyed the sheet of paper contained in the tube at the time it was struck.

The condition of the cylinder after the bolt had struck it is altogether unlike that of the tube described and illustrated by Professor Humphreys, Physics of the Air (pp. 391–396).

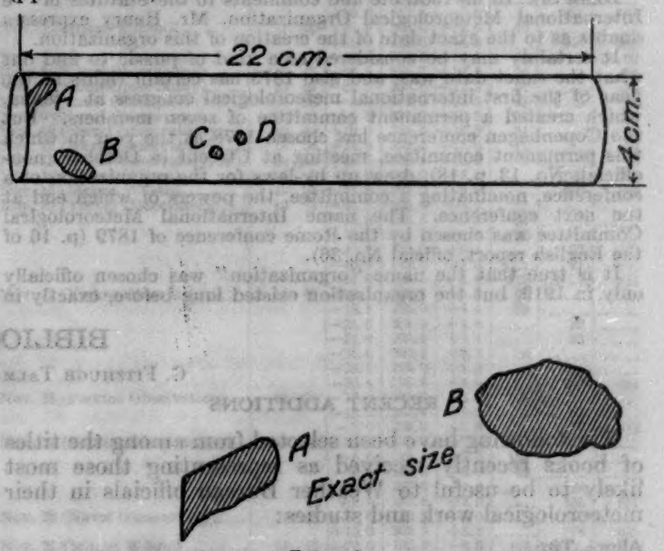

FIGURE 1

Precipitation from air in moist-labile equilibrium,[1] *by A. Refsdal, Geofysiske Publ. 5. 12, pp. 1-71, 1930.*—Air is stated to be in labile equilibrium when its temperature gradient lies between 1.0 and 3.41° C./100 m., while the expression "feuchtlabile" is used for the case where equilibrium is stable for unsaturated but labile for saturated air masses, a condition which frequently occurs. In the "feuchtlabile" region the temperature gradient decreases rapidly with temperature and it occurs more frequently in summer than winter and nearer the surface than above. In the subsequent treatment the author considers: (1) The conditions for stability in the atmosphere; (2) the linear arrangement of local rain and thundery squalls using aerological evidence as indications of fronts in the upper air, the existence of superadiabatic gradients, and applications of the theory to actual weather charts; (3) the "feuchtlabile" night rain is tested by observations at As, and two series of charts; (4) action of local topography; (5) "feuchtlabile" equilibrium and cyclonic activity are considered in two series of charts and the effects of waves and vortices applied; (6) the theory of cyclones is applied to the cases arising in tropical λ, polar and temperate latitudes; (7) the determination of the vertical acceleration and friction for air masses; and (8) the relation of the precipitation to the semidiurnal wave of pressure.—*R. S. R.*

Polish Meteorological Institute Annual for 1928.—The Polish Annual for 1928, which has just appeared, is much

[1] Reprinted from Science Abstracts, vol. 33:894.

more extensive than that for 1927, and we are promised an early publication of the 1929 annual, also that for 1926. Annuals for earlier years will be published hereafter at the rate of about two per year. The new annual contains a general discussion in both Polish and French of the net-work of stations and the types of observations. The data for 12 stations are published in extenso by days. Those for 122 stations are fairly complete, while data for rainfall comprise the reports from the 946 remaining stations of the Polish Weather Service. The details concerning locations, exposures, and heights of the 1,080 stations are presented in Polish (pp. 10–124).—*C. F. B.*

The International Meteorological Committee, Prof. E. van Everdingen, President.—The editor has received the following letter from Professor van Everdingen. The letter is self-explanatory.

DEAR SIR: In his footnote and comments to the Statutes of e International Meteorological Organization, Mr. Henry expresses doubts as to the exact date of the creation of this organization.

It certainly may be considered as a kind of puzzle to find out what the exact date was, and also 1873 has certain rights as the year of the first international meteorological congress at Vienna, which created a permanent committee of seven members. But the Copenhagen conference has chosen 1878 as the year in which this permanent committee, meeting at Utrecht in October (non-official, No. 13, p. 18), drew up by-laws for the organization of a conference, nominating a committee, the powers of which end at the next conference. The name International Meteorological Committee was chosen by the Rome conference of 1879 (p. 16 of the English report, official No. 36).

It is true that the name "organization" was chosen officially only in 1919, but the organization existed long before, exactly in the way as described by Mr. Henry in his last sentences on page 156. It is strange therefore that he should identify on page 155 the organization with the committee, which is only one of its parts. As this mistake occurs frequently with persons not familiar with our meetings, I have thought it worthwhile to draw attention to it when appearing in so prominent a place.

(Signed) E. VAN EVERDINGEN,
President, International Meteorological Committee.

End of the 1930 drought in the Potomac Basin.—A substantial rain of 0.94 inch in 24 hours fell on December 26–27, 1930, and this rain probably marked the termination of the severe drought that has persisted in Atlantic seaboard States for about one year. The rainfall at Washington, D. C., for 1930 up to the end of the year was deficient 20.50 inches, or 51 per cent of the normal annual precipitation.—*A. J. H.*

Climatological summary for Chile, October, 1930 (by J. Bustos Navarrete, Observatorio del Salto, Santiago, Chile).—Intensification in the atmospheric circulation over the Pacific Ocean was accompanied by a return of unsettled weather, depressions being mapped during the periods 2d–4th, 12th–13th, 21st–23d, 24th, and 27th–28th. Anticyclonic conditions marked the following periods: 1st–3d, 5th–7th, 7th–10th, 14th–16th, 19th–21st, and 28th–30th. Unsettled weather and rain abated at the close of the month.

The most notable feature of the month was the violent electrical storm at Santiago on the evening of the 13th.—*Translated by W. W. R.*

BIBLIOGRAPHY

C. FITZHUGH TALMAN, in charge of Library

RECENT ADDITIONS

The following have been selected from among the titles of books recently received as representing those most likely to be useful to Weather Bureau officials in their meteorological work and studies:

Alippi, Tito.
La previsione del tempo. Bologna. [1930.] viii, 165 p. figs. plates. 24 cm.

Friedrich, Wilhelm.
Die Messung der Verdunstung vom Mittellandkanal bei Sehnde in den Jahren 1925 bis 1927. Berlin. 1930. 51 p. illus. 35 cm. (Jahrb. für die Gewässer. Norddeutsch. Bes. Mitt. Bd. 6, Nr. 1.)

Glasspoole, John.
Areas covered by intense and widespread falls of rain. With an abstract of the discussion upon the paper. Ed. by H. H. Jeffcott. London. 1930. p. 137–194. figs. 21½ cm. (Exc.: Minutes of proc. Inst. civil engin. v. 229. sess. 1929–1930. pt. 1.)

International geodetic and geophysical union.
Photographic atlas of auroral forms and scheme for visual observations of aurorae. Oslo. 1930. 24 p. plates. 30 cm.

Knoch, Karl.
Klima und Klimaschwankungen. Leipzig. 1930. 150 p. figs. 18½ cm. (Wissenschaft und Bildung. 269.)

Marmer, H. A.
Gulf stream and its problems. Washington. 1930. p. 285–307. figs. 25 cm. (Smith. rep., 1929.)

Mathias, E.
La foudre, ses différentes formes—la matière fulminante. no. 1–5. Paris. n. d. figs. 24½ cm. (Extr.: Annales des postes, télég. et téléph. Nov. 1927; juil. 1928: août, oct., déc. 1929.)

Monographie de l'éclair fulgurant. Compléments relatifs à ses formes terminales. Paris. 1930. 117 p. figs. plates. 24 cm. (Bull. de l'Inst. et observ. de phys. du globe du Puy-de-Dome. no. 2. 1930.)

Remarques sur la pression électrostatique des foudres sphériques. Paris. n. d. 7 p. 24 cm. (Extr.: Annales des postes, télég., et téléph. (Avril 1930.))

Russia. Hydro-meteorological section.
. . . Album of ice forms. Leningrad. 1930. 16 p. plates. 17⅞ cm. [Author, title and text in Russian and English.]

Sarasola, Simon.
Ley fundamental de la circulacion ciclonica a diversas alturas. [Habana. 1930.] 2 sheets. 50½ cm. (Bol. hidrog. Habana. no. 99–100. Feb. 10, 25, 1930.)

Movimientos del mar en los ciclones. Su importancia en la revision . . . [Habana. 1930.] 2 sheets. 50½ cm. (Bol. hidrog. Habana. no. 102–103. Mar. 25, Abr. 10, 1930.)

SOLAR OBSERVATIONS

SOLAR AND SKY RADIATION MEASUREMENTS DURING NOVEMBER, 1930

By HERBERT H. KIMBALL

For reference to descriptions of instruments and exposures, and an account of the method of obtaining and reducing the measurements, the reader is referred to this volume of the REVIEW, page 26.

Table 1 shows that solar radiation intensities averaged above the normal intensity for November at Washington, D. C., and slightly below normal at Madison, Wis., and Lincoln, Nebr.

Table 2 shows an excess in the total solar radiation received on a horizontal surface directly from the sun and diffusely from the sky at Madison, Lincoln, Chicago, Twin Falls and La Jolla, and a deficiency at Washington, New York, and Fresno.

Skylight polarization measurements were obtained at Washington on November 6 only and give a percentage of 52. At Madison, measurements obtained on 4 days give a mean of 62 per cent and a maximum of 68 per cent on the 22d. The values for both stations are considerably below the corresponding November averages for the respective stations.

TABLE 1.—*Solar radiation intensities during November, 1930*

[Gram-calories per minute per square centimeter of normal surface]

Washington, D. C.

Date	Sun's zenith distance: 8 a.m.	78.7° A.M.	75.7° A.M.	70.7° A.M.	60.0° A.M.	0.0°	60.0° P.M.	70.7° P.M.	75.7° P.M.	78.7° P.M.	Noon
	75th mer. time	Air mass									Local mean solar time
	e.	5.0	4.0	3.0	2.0	[1] 1.0	2.0	3.0	4.0	5.0	e.
	mm.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*mm.*
Nov. 1	3.99	0.86	1.00	1.08							3.00
Nov. 6	2.49						1.22	0.96	0.75	0.55	2.49
Nov. 7	1.88				1.19		1.12	0.94	0.84		2.36
Nov. 8	2.74				1.35		1.35	1.20	1.01		2.36
Nov. 10	4.37	0.71	0.86	0.98	1.12						3.81
Nov. 28	1.07		0.95	1.19	1.26			1.12	0.90	0.66	0.96
Means		(0.78)	0.94	1.08	1.26		1.23	1.06	0.88	(0.60)	
Departures		+0.03	+0.08	+0.08	+0.08		+0.06	+0.07	+0.04	−0.13	
Madison, Wis.											
Nov. 4	5.16				1.07			0.94			5.16
Nov. 5	2.87	1.06	1.15	1.26	1.42			1.22			2.16
Nov. 6	2.26		1.13	1.26	1.36			1.18			1.78
Nov. 7	2.36				1.23			0.83			2.06
Nov. 10	4.95		0.57	0.77	1.10			0.89			5.56
Nov. 12	6.76	0.69	0.80	1.00	1.15						7.57
Nov. 17	4.57							0.96			5.36
Nov. 19	6.76				0.98						8.48
Nov. 22	3.63							1.19			3.99
Means		(0.88)	0.91	1.07	1.19			1.03			
Departures		±0.00	−0.10	−0.07	−0.10			−0.10			
Lincoln, Nebr.											
Nov. 4	4.37		0.82	1.01	1.34		1.25	1.00	0.95	0.77	4.17
Nov. 5	2.49		1.11	1.26				1.21	1.10	0.97	1.96
Nov. 8	3.81		0.78	0.94	1.18		1.19	1.01	0.85	0.73	6.50
Nov. 10	7.04	0.91	1.02	1.12	1.31		1.30				7.87
Nov. 11	6.50	0.51	0.78	0.98	1.12						4.95
Nov. 13	6.50	0.91	1.02	1.16	1.32			1.11	0.94	0.83	7.29
Nov. 17	4.95	0.63	0.80	1.09	1.37		1.40	1.22	1.08	0.96	6.02
Nov. 18	5.36	0.63	0.73	0.92	1.24		1.26	1.12	1.00	0.83	7.29
Nov. 21	2.87	1.01	1.09	1.28	1.45			1.27			3.00
Nov. 22	3.45	1.00	1.06	1.26							3.63
Nov. 25	3.63		1.15	1.24							2.87
Means		0.80	0.94	1.12	1.29		1.28	1.13	0.99	0.85	
Departures		−0.10	−0.08	−0.05	−0.07		−0.07	−0.06	−0.05	−0.07	

[1] Extrapolated.

TABLE 2.—*Total solar radiation (direct + diffuse) received on a horizontal surface*

Week beginning	Average daily totals: Washington	Madison	Lincoln	Chicago	New York	Twin Falls	Pittsburgh	Gainesville	Fresno	La Jolla	Miami
1930											
Oct. 29	242	220	306	147	120	305	133	319	334	521	336
Nov. 5	247	225	286	136	188	234	138	309	281	276	279
Nov. 12	81	128	229	86	68	178	83	281	196	210	341
Nov. 19	137	110	176	86	113	162	161	293	280	292	317
Nov. 26	214	156	186	87	138	164	116	266	217	233	187
	Departures from weekly normals										
Oct. 29	+6	+36	+66	+10	−48	+29			+21	+55	
Nov. 5	+20	+56	+57	+20	+45	+31			−4	+22	
Nov. 12	−105	−9	+29	−13	−54	−39			−63	−42	
Nov. 19	−41	−20	−27	−5	+4	+39			+38	+26	
Nov. 26	+55	+30	+1	+5	+41	+50			+5	−47	
Accumulated departures on Dec. 2	+8183	+1806	−1218	+679	+1176				−2136	−1412	

POSITIONS AND AREAS OF SUN SPOTS

[Communicated by Capt. J. F. Hellweg, Superintendent United States Naval Observatory. Data furnished by Naval Observatory, in cooperation with Harvard, Yerkes, Perkins, and Mount Wilson Observatories. The differences of longitude are measured from central meridian, positive west. The north latitudes are plus. Areas are corrected for foreshortening and are expressed in millionths of sun's visible hemisphere. The total area, including spots and groups, is given for each day in the last column]

Date	Eastern standard civil time	Heliographic: Diff. long.	Heliographic: Longitude	Heliographic: Latitude	Area: Spot	Area: Group	Total area for each day
1930	h m	°	°	°			
Nov. 1 (Naval Observatory)	10 40	+37.0	116.2	−5.0		231	
		+38.0	117.2	−10.0		46	
		+51.0	130.2	−7.0		525	802
Nov. 2 (Naval Observatory)	10 45	+49.5	115.5	−11.0	12		
		+53.5	119.5	−5.0		278	
		+65.5	131.5	−8.0		401	691
Nov. 3 (Naval Observatory)	10 44	−76.0	336.8	+12.5	77		
		+62.5	115.3	−11.0	9		
		+67.0	119.8	−13.0	6		
		+67.5	120.3	−5.0		278	
		+80.0	132.8	−7.0		231	601
Nov. 4 (Mount Wilson)	11 40	−61.0	338.0	+12.0	66		
		+85.0	124.0	−6.0		260	326
Nov. 5 (Naval Observatory)	13 16	−46.5	338.5	+12.5	62		62
Nov. 6 (Naval Observatory)	10 47	−34.5	338.7	+12.5	56		56
Nov. 7 (Naval Observatory)	10 43	−21.5	338.6	+12.5	56		56
Nov. 8 (Naval Observatory)	13 18	−6.5	339.0	+12.5	43		43
Nov. 9 (Naval Observatory)	10 45	+6.0	339.7	+12.5	34		34
Nov. 10 (Naval Observatory)	10 49	+19.0	339.5	+13.0	31		31
Nov. 11 (Naval Observatory)	13 58	+34.0	339.5	+13.0	12		12
Nov. 12 (Naval Observatory)	10 45	+45.5	339.6	+13.0	9		9
Nov. 14 (Mount Wilson)	14 0	−66.0	200.0	+5.0		299	299
Nov. 15 (Mount Wilson)	13 20	−51.0	202.2	+5.0		400	400
Nov. 16 (Yerkes Observatory)	12 33	−33.8	206.6	+3.2	51		
		−34.9	205.5	+3.5	29		
		−37.7	202.7	+4.7	26		
		−37.4	203.0	+5.4		22	
		−40.9	199.5	+7.6		71	
		−44.0	196.4	+3.0	112		311
Nov. 17 (Yerkes Observatory)	14 48	−18.1	207.9	+4.3	98		
		−19.1	206.9	+4.4	62		
		−21.6	204.4	+4.6		22	
		−22.4	203.6	+5.4		36	
		−25.6	200.4	+6.2	16		
		−26.1	199.9	+8.2		28	
		−30.4	195.6	+4.9		202	464
Nov. 18 (Perkins Observatory)	10 30	−17.0	197.9	+3.5	124		
		−12.5	202.4	+5.0		93	
		−5.0	209.9	+3.0		155	372
Nov. 19 (Perkins Observatory)	9 10	−72.5	130.0	−7.0		186	
		−4.0	198.5	+2.5	124		
		−0.5	202.0	+5.0	62		
		+4.5	207.0	+4.0		124	
		+9.0	211.5	+3.0		155	651
Nov. 20 (Naval Observatory)	12 18	−57.0	130.8	−8.0		370	
		+15.0	202.8	+3.5		278	648
Nov. 21 (Mount Wilson)	11 45	−72.0	102.9	−8.0	444		
		−71.0	103.9	+8.0		130	
		−40.0	134.9	−6.0		264	
		+32.0	206.9	+2.0		202	1,130
Nov. 22 (Naval Observatory)	14 24	−66.0	94.3	+3.5	62		
		−57.5	102.8	+5.5	123		
		−57.0	103.3	−9.5		62	
		−27.0	133.3	−7.5		216	
		+45.0	205.3	+3.5		278	741
Nov. 23 (Naval Observatory)	11 1	−54.5	94.5	+4.0		62	
		−46.0	103.0	+6.0	108		
		−45.0	104.0	−9.0		386	
		−16.0	133.0	−7.5	216		
		+56.5	205.5	+3.5		231	1,003
Nov. 24 (Naval Observatory)	12 42	−39.5	95.4	+3.5	46		
		−32.0	102.9	+5.5	93		
		−31.0	103.9	−9.0		401	
		−0.5	134.4	−7.0		216	
		+47.5	182.4	−27.5		46	
		+74.0	208.9	+3.5		247	1,049
Nov. 25 (Naval Observatory)	11 32	−27.5	94.8	+4.0	15		
		−19.5	102.8	+5.7	77		
		−18.0	104.3	−9.0		401	
		+12.5	134.8	−7.5	108		
		+61.0	183.3	−27.5		77	678
Nov. 26 (Naval Observatory)	10 43	−49.5	60.1	+8.5	22		
		−35.5	74.1	+14.5		43	
		−12.0	97.6	+3.0		15	
		−7.5	102.1	+4.5		77	
		−5.5	104.1	−9.5		386	
		+26.0	135.6	−8.0		108	
		+78.5	188.1	−28.0	154		805
Nov. 27 (Naval Observatory)	11 0	−47.5	48.8	+17.5	31		
		−36.0	60.3	+8.0		62	
		+7.5	103.8	+5.0		46	
		+8.0	104.3	−9.5		324	
		+40.5	136.8	−8.0		93	556

POSITIONS AND AREAS OF SUN SPOTS—Continued

Date	Eastern standard civil time	Heliographic			Area		Total area for each day
		Diff. long.	Longitude	Latitude	Spot	Group	
1930	h m	°	°	°			
Nov. 28 (Naval Observatory)	12 5	−51.5	31.0	+7.0		93	
		−33.5	49.0	+17.5		46	
		−21.5	61.0	+8.0		108	
		−9.5	73.0	+16.5		22	
		+22.0	104.5	+5.5		31	
		+23.0	105.5	−9.0		340	
		+55.5	138.0	−7.0		46	686
Nov. 29 (Naval Observatory)	11 40	−37.0	32.5	+7.0		77	
		−21.0	48.5	+19.5		31	
		−8.5	61.0	+8.0		93	
		+10.0	79.5	+14.5		77	
		+35.0	104.5	+16.0		37	
		+35.5	105.0	−9.0		324	639
Nov. 30 (Mount Wilson)	13 30	−19.0	36.4	+8.0		42	
		−1.0	54.4	+17.0		1	
		+7.0	62.4	+9.0		27	
		+25.0	80.4	+15.0		101	
		+50.0	105.4	−9.0		374	
		+51.0	106.4	+6.0	2		547
Mean daily area for November							472

PROVISIONAL RELATIVE SUN-SPOT NUMBERS FOR NOVEMBER, 1930 [1]

[Data furnished through the courtesy of Prof. W. Brunner, University of Zurich, Switzerland]

November, 1930	Relative numbers	November, 1930	Relative numbers	November, 1930	Relative numbers
1	57	11	8	21	dd 66
2	41	12	14	22	70
3	25	13	0	23	68
4	27	14	12	24	a 51
5	16	15	d 14	25	Wc 58
6	8	16		26	Eabc 76
7	8	17	26	27	72
8	9	18	d 31	28	67
9	8	19	b	29	61
10	15	20	61	30	54

Mean, 28 days=36.5.

[1] Dependent alone on observations at Zurich and its station at Arosa.

a=Passage of an average-sized group through the central meridian.
b=Passage of a large group through the central meridian.
c=New formation of a large or average-sized center of activity: E, on the eastern part of the sun's disk; W, on the western part; M, in the central zone.
d=Entrance of a large or average-sized center of activity on the east limb.

AEROLOGICAL OBSERVATIONS

By L. T. SAMUELS

Free-air temperatures during November were considerably above normal at Ellendale, moderately above at Royal Center, slightly below at Broken Arrow and moderately below at Groesbeck and Due West. (See Table 1.) This is in close agreement with the distribution of surface departures shown in Chart I.

The departures of free-air relative humidities were in general, of opposite sign to those of temperature.

Free-air vapor pressures were above normal at all levels at Ellendale, Royal Center, and Broken Arrow and in the upper levels at Due West and Groesbeck.

From Table 2, it will be noted that free-air temperatures at the naval air station, Pensacola, were in close agreement with those at Groesbeck, being slightly higher at the former station. Those at San Diego were highest of all stations.

At 1,000 meters above sea level the free-air resultant winds indicated a southwesterly component over the middle Mississippi Valley and lower Lake region and northwesterly and westerly over the remainder of the country. At 3,000 meters none of the resultant directions contained an appreciable southernly component, except in the extreme Northwest. The easterly component found at 1,000 meters over Brownsville and Key West changed to westerly at 2,000 meters over Brownsville and to north-northwesterly at 3,000 meters over Key West. The monthly resultants for a representative group of stations are shown in Table 3.

A very severe sleet storm occurred at Ellendale on the 18th, 19th, and 20th. The kite record of the 18th was of unusual interest in that it showed a marked rise in temperature from the 17th to 18th between 3,000 and 3,500 meters. The increase amounted to 7° C. at the higher level and was unquestionably greater at still higher elevations beyond the limit of the flight. A significant feature of this high inversion was the fact that the air within it was saturated and 10-tenths altostratus clouds from the south-southeast prevailed. On the morning of the 18th a deep LOW (29.3 in.) was central over Colorado.

TABLE 1.—*Free-air temperatures, relative humidities, and vapor pressures during November, 1930*

TEMPERATURE (° C.)

Altitude (meters) m. s. l.	Broken Arrow, Okla. (233 meters)		Due West, S. C. (217 meters)		Ellendale, N. Dak. (444 meters)		Groesbeck, Tex. (141 meters)		Royal Center, Ind. (225 meters)	
	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal
Surface	8.2	−1.5	7.7	−2.9	0.6	+2.9	10.0	−3.2	5.4	+0.7
500	8.3	−0.3	7.2	−2.4	0.7	+3.0	10.9	−1.5	4.3	+1.2
1,000	7.7	+0.3	6.0	−1.9	2.7	+4.6	9.5	−1.7	2.8	+1.2
1,500	5.7	−0.7	4.9	−1.5	2.5	+4.7	7.8	−1.8	1.5	+1.2
2,000	3.8	−0.9	3.1	−1.6	0.7	+4.5	5.9	−1.8	0.4	+1.9
2,500	1.4	−1.1	0.8	−2.1	−1.6	+4.4	2.9	−2.7	−1.9	+1.5
3,000	−0.7	−0.8	−2.0	−2.7	−4.3	+4.3	0.3	−2.9	−4.4	+1.3
4,000	−8.8	−4.0	−8.0	−3.2	−9.6	+4.7	−6.1	−3.9	−10.2	+0.3
5,000					−15.4	+4.2				

RELATIVE HUMIDITY (%)

Surface	68	+1	74	+3	70	−8	75	+1	73	0
500	64	0	68	+2	69	−7	59	−8	70	−2
1,000	58	−1	63	+1	57	−8	51	−8	65	−2
1,500	55	+3	57	0	51	−7	43	−9	52	−7
2,000	53	+6	54	+2	50	−5	45	−1	44	−10
2,500	48	+5	48	+4	53	−1	46	+6	40	−10
3,000	45	+3	59	+18	56	+2	43	+7	40	−9
4,000	45	+10	65	+30	54	−2			36	−9
5,000					54	+4				

VAPOR PRESSURE (*mb.*)

Surface	7.80	−0.42	8.79	−0.85	4.37	+0.13	10.34	−1.69	7.73	+1.13
500	7.47	+0.07	7.97	−0.53	4.32	+0.16	8.74	−1.79	6.89	+1.05
1,000	6.39	+0.16	6.85	−0.34	4.09	+0.53	6.81	−1.70	5.79	+0.97
1,500	5.25	+0.20	5.69	−0.06	3.60	+0.52	4.88	−1.69	4.18	+0.37
2,000	4.48	+0.56	4.77	+0.28	3.04	+0.43	4.38	−0.51	3.21	+0.17
2,500	3.47	+0.42	4.04	+0.84	2.66	+0.45	3.69	−0.11	2.49	+0.02
3,000	2.75	+0.29	4.31	+1.87	2.25	+0.44	3.09	+0.33	2.25	+0.09
4,000	1.61	+0.27	3.63	+2.51	1.47	+0.28			1.89	+0.63
5,000					0.91	+0.20				

TABLE 2—*Free-air data obtained at naval air stations during November, 1930*

Altitude (meters) m. s. l.	TEMPERATURE (° C.)		RELATIVE HUMIDITY (%)	
	Pensacola, Fla.	San Diego, Calif.	Pensacola, Fla.	San Diego, Calif.
Surface	11.3	19.1	82	81
500	10.4	17.6	76	48
1,000	9.0	16.6	72	42
2,000	6.2	10.7	61	38
3,000	2.6	5.0	46	35

TABLE 3.—*Free-air resultant winds (meters per second) based on pilot balloon observations made near 7 a. m. (E. S. T.) during November, 1930*

Altitude (meters) m.s.l.	Broken Arrow, Okla. (233 meters)		Brownsville, Tex. (12 meters)		Burlington, Vt. (132 meters)		Cheyenne, Wyo. (1,873 meters)		Due West, S. C. (217 meters)		Ellendale, N. Dak. (444 meters)		Groesbeck, Tex. (139 meters)		Havre, Mont. (762 meters)		Jacksonville, Fla. (14 meters)		Key West, Fla. (11 meters)		Los Angeles, Calif. (145 meters)		Medford, Oreg. (410 meters)	
	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity
	°		°		°		°		°		°		°		°		°		°		°		°	
Surface	S 16 W	1.2	N 52 W	0.7	S 4 W	3.0	N 69 W	5.6	N 1 E	1.6	N 44 W	3.4	N 25 E	0.7	W	2.0	N 9 W	1.2	N 42 E	3.2	N 49 W	1.7	S 51 W	0.3
500	S 39 W	4.3	S 47 E	3.6	S 22 W	6.9	----------	----	N 25 E	2.6	N 46 W	3.8	N 11 W	0.4	----------	----	N 1 E	1.4	N 59 E	8.4	N 70 E	1.3	N 86 W	0.3
1,000	N 83 W	5.6	S 71 E	2.8	S 63 W	6.9	----------	----	N 24 W	2.1	N 33 W	7.5	N 64 W	3.0	S 79 W	5.8	S 62 W	1.4	N 68 E	6.0	N 72 E	1.6	S 39 E	1.6
1,500	N 62 W	5.7	S 10 W	2.6	S 63 W	8.4	----------	----	N 68 W	3.7	N 37 W	9.3	N 62 W	6.5	N 66 W	8.3	S 80 W	2.9	N 78 E	3.3	N 40 E	1.3	S 23 E	2.6
2,000	N 68 W	6.8	S 69 W	1.6	S 86 W	12.7	N 67 W	8.5	N 66 W	6.6	N 59 W	8.0	N 76 W	7.1	N 61 W	9.5	N 81 W	6.2	N 82 E	1.5	S 64 E	1.1	S 30 W	2.3
2,500	N 86 W	6.8	S 73 W	2.8	N 78 W	9.2	N 52 W	10.5	N 74 W	10.0	N 63 W	8.4	N 82 W	7.0	N 67 W	11.2	N 78 W	8.4	N 7 E	1.5	N 11 E	2.7	S 51 W	2.6
3,000	S 88 W	7.0	N 55 W	0.7	N 64 W	10.7	N 54 W	9.5	N 65 W	11.1	N 77 W	7.6	N 76 W	5.5	N 56 W	13.1	N 78 W	9.3	N 15 W	0.6	N	5.1	S 58 W	4.0
4,000	----------	----	N 50 W	2.3	----------	----	N 66 W	8.2	N 65 W	8.0	N 70 W	7.4	N 70 W	6.3	----------	----	N 77 W	11.7	N 40 W	2.4	----------	----	S 81 W	6.1
5,000	----------	----	----------	----	----------	----	N 54 W	5.7	S 83 W	7.6	----------	----	----------	----	----------	----	----------	----	N 69 W	3.7	----------	----	----------	----

Altitude (meters) m.s.l.	Memphis, Tenn. (145 meters)		Modena, Utah (1,665 meters)		New Orleans, La. (25 meters)		Omaha, Nebr. (321 meters)		Phoenix, Ariz. (356 meters)		Royal Center, Ind. (225 meters)		Salt Lake City, Utah (1,294 meters)		San Francisco, Calif. (8 meters)		Sault Ste. Marie, Mich. (198 meters)		Seattle, Wash. (14 meters)		Spokane, Wash. (606 meters)		Washington, D. C. (10 meters)	
	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity
	°		°		°		°		°		°		°		°		°		°		°		°	
Surface	S 49 W	1.1	S 84 W	1.6	N 5 E	1.3	S 9 E	1.2	N 81 E	3.4	S 27 W	1.9	S 46 E	1.7	N 75 E	1.0	S 6 W	0.5	S 52 E	0.4	S 47 E	0.7	N 81 W	0.4
500	S 50 W	3.9	----------	----	N 11 E	3.9	S 35 W	4.6	N 74 E	4.1	S 61 W	6.7	----------	----	N 9 E	3.0	S 67 W	2.0	S 13 W	1.8	----------	----	W	4.0
1,000	S 79 W	6.0	----------	----	N 31 W	2.6	S 78 W	7.7	S 88 E	3.6	S 74 W	7.1	----------	----	N 10 E	3.6	N 73 W	4.8	S 26 W	6.9	S 13 E	2.7	N 88 W	7.1
1,500	S 87 W	6.0	----------	----	N 26 W	7.0	N 86 W	6.9	S 62 E	3.1	S 74 W	7.3	S 63 E	0.9	N 2 E	2.2	S 84 W	8.3	S 40 W	6.3	S 33 W	5.1	N 69 W	8.5
2,000	N 83 W	5.2	N 36 E	2.2	N 36 W	7.0	N 87 W	6.9	S 49 E	1.1	S 71 W	9.5	N 15 E	0.6	N 13 E	2.4	S 79 W	9.7	----------	----	S 57 W	7.2	N 83 W	6.6
2,500	N 51 W	7.3	N 39 E	4.3	N 18 W	5.4	S 89 W	10.4	S 66 E	1.3	N 83 W	8.0	N 22 W	1.5	N 25 E	5.2	----------	----	----------	----	S 67 W	9.8	N 75 W	6.4
3,000	----------	----	N 36 E	3.4	N 21 W	5.2	S 89 W	7.8	N 58 E	0.9	----------	----	N 24 W	3.3	N 20 E	5.4	----------	----	----------	----	S 72 W	10.2	W	7.3
4,000	----------	----	N 14 E	4.5	----------	----	N 44 W	9.0	N 28 E	2.8	----------	----	N 37 W	4.1	----------	----	----------	----	----------	----	----------	----	----------	----
5,000	----------	----	N 15 E	5.1	----------	----	----------	----	----------	----	----------	----	N 75 W	2.9	----------	----	----------	----	----------	----	----------	----	----------	----

TABLE 4.—*Observations by means of kites, captive and limited height sounding balloons during November, 1930*

	Broken Arrow, Okla.	Due West, S. C.	Ellendale, N. Dak.	Groesbeck, Tex.	Royal Center Ind.
Mean altitudes (meters) m. s. l. reached during month	2,614	2,285	3,233	2,309	2,828
Maximum altitudes (meters) m. s. l. reached and date	4,406	4,274	5,549	4,070	4,345
Number of flights made	28	29	27	17	26
Number of days on which flights were made	28	28	22	17	26

In addition to the above there were 163 scheduled pilot balloon observations made daily at 56 Weather Bureau stations in the United States.

WEATHER IN THE UNITED STATES

THE WEATHER ELEMENTS

By M. C. BENNETT

GENERAL SUMMARY

The first decade of November was warm for the season throughout much of the western section of the country, but it was generally cool in the Central and Eastern States. Thereafter, unusually high temperatures prevailed generally in the East until near the end of the month, when they were abnormally low, with freezing weather as far south as northern Florida. As a whole, the month averaged warmer than normal from the northern and central Great Plains eastward to the Atlantic Ocean, but in the South, the more eastern States, and the Ohio Valley, it was near the normal. Decidedly cold weather for the season prevailed in much of the far Northwest, especially in the northern and central Great Basin, while it was decidedly above normal in the south Pacific area.

For the month as a whole, precipitation substantially above normal was received over an area from southwest Virginia southwesterly to the Gulf, with some portions of the southern sections receiving from two to four times the normal amount. Heavy falls were received also in the central and northern Great Plains, the central Rocky Mountains, the Great Basin, and southern California. On the other hand, much of the far Northwest, the northern Rocky Mountain districts, and parts of the Ohio Valley and the Middle Atlantic States received less than half the average for November. Light snow fell as far south as Georgia, and some heavy falls were received in the upper Lake region and much of the Northwest.

TEMPERATURE

The very first days were abnormally cool practically everywhere east of the Rocky Mountain divide, and the first 10 days of November, as a whole, were cooler than normal in the eastern half of the country, especially in the lower Mississippi Valley and to the eastward, but were mild in the West.

The middle decade of the month and the first half of the final decade were comparatively warm east of the Rocky Mountains, particularly in the Lake region and the upper Mississippi Valley, but were cool west of the Rockies, save on the California coast. The final half of the last decade was cold from the Plains region eastward and in most of the Plateau region; but was milder than normal in the northern Rocky Mountain States, near the Mexican border, and near the Pacific coast.

The month of November showed great contrast in the prevailing temperature conditions in different parts of the country, as is to be expected during the colder portion of the year. Part of the upper Mississippi Valley averaged about 5° warmer than normal, while some districts in the middle and northern Plateau averaged 6° colder than normal. Almost all of the Rocky Mountain region and the country to the westward, and practically all parts of the Gulf and South Atlantic States averaged cooler than normal. Most middle and northern areas east of the Rockies showed positive departures, which were considerable in a strip from North Dakota to New York. Also much of the Pacific coast area and a large part of interior California averaged warmer than normal.

The highest temperatures were usually recorded very early in the month in the far Southwest, but on various dates in the far Northwest, and on or about the 10th in some north-central districts. In nearly all States from the Plains eastward to the Atlantic coast they occurred during the period from the 14th to the 22d, and the highest readings on the 18th or 19th in much of the Mississippi and lower Ohio Valleys and the upper Lake region were among the highest temperatures ever recorded in those districts during November.

The lowest temperatures in the eastern half of the country were almost invariably noted during the final four days, and in many areas they were nearly or quite the lowest November marks of record. The western half showed less uniformity in time of occurrence, but in a considerable number of States the lowest readings occurred in the period from the 18th to the 22d, or just when unusual warmth for November prevailed in most of the eastern half.

PRECIPITATION

Not much precipitation occurred during the first decade, save in scattered areas of limited extent. About the middle of the month heavy rain fell in most of the Southeastern States, and considerable near the coast from New Jersey to southwestern Maine, while much of the far West had important precipitation. The more noteworthy precipitation afterward, till the end of November, occurred in the middle and northern Plains, the Mississippi Valley, near the east Gulf coast, and in portions of the Lake region and the far Southwest.

As a whole, the November precipitation was very unevenly distributed over the country, yet the majority of the States received more than normal quantities. In particular, nearly all of the Southeast had a marked excess, notably Alabama and the western parts of Florida and Georgia. Very different was the situation in districts to northward. In northern New England, interior New York, Pennsylvania, and thence southward to northern Virginia, southwestward to the central valleys, and northwestward to central Wisconsin, there was a marked shortage. This month is found to be the ninth to twelfth month in succession drier than normal in Maryland, northern and eastern Virginia, West Virginia, Kentucky, and Ohio, and at least the fifth for most parts of the Lake region.

Northwestern Texas and the adjacent portion of Oklahoma mainly had less precipitation than normal, also much of the northern Rocky Mountain region, northern Idaho, Washington, Oregon, and northwestern California.

In addition to the Southeast, already mentioned, there was more precipitation than normal in much of the upper Mississippi Valley, especially that portion west of the river, in practically all the middle and northern plains, in the Rio Grande Valley and most of the middle and southern plateau, and in much of central and southern California.

SNOWFALL

Considerable snow fell in many north-central and northwestern districts, particularly central and southern Idaho, northern Nevada, and most of Utah, Colorado, and northern New Mexico. Most of this occurred about the middle of the month, falling within a few days, with a decided interruption of traffic and some loss of livestock.

Large portions of Montana and the Dakotas likewise had much snowfall. In the Lake region, most of upper Michigan and several western counties of the lower peninsula had much snowfall, and there was considerable during the final week of November in northeastern Ohio and parts of the central Appalachian region, while enough to measure was noted as far south as the elevated portion of northern Georgia. Moderate amounts of snow fell in most of the Northeast.

SUNSHINE AND RELATIVE HUMIDITY

Much cloudy weather prevailed in the East, the Gulf States, the Lake region, the far Northwest and the North Pacific States. Elsewhere rather a large amount of sunshine prevailed, especially in the great central valleys, the central and southern Rocky Mountain region, and westward to the Pacific, a number of locations receiving from 15 to 20 per cent or more above the normal. The relative humidity was above the normal in much of the East, the northern Rocky Mountain and plateau regions, while throughout the Great Plains, the central and southern Pacific regions it was, as a rule, below the normal. However, the departures from the normal were nowhere large.

SEVERE LOCAL STORMS, NOVEMBER, 1930

[The table herewith contains such data as have been received concerning severe local storms that occurred during the month. A more complete statement will appear in the Annual Report of the Chief of Bureau]

Place	Date	Time	Width of path, yards	Loss of life	Value of property destroyed	Character of storm	Remarks	Authority
Norfolk, Va.	4					High tides and wind.	Low areas flooded; beaches badly washed; traffic interrupted; considerable minor damage by wind.	Official, U. S. Weather Bureau.
Florida (east coast)	7–11			6		High seas and wind.	Schooner sunk; tug beached; steamed disabled; another vessel foundered.	Do.
Foreman, Ark. (4 miles southeast).	15	12:30 p. m.	67		$600	Tornado	Details of damage not reported; path 5 miles.	Do.
Addicks, Tex. (near)	15	12:45 p. m.	16	1	250	do	2 farm houses damaged; 3 persons injured; path 9 miles long.	Do.
Winnsboro, La. (near)	15	4:30 p. m.	400	1	21,000	do	Dwellings and barns destroyed; some timber blown down; several persons injured; path 4 miles.	Do.
Hemphill to Ball, La.	15	5:15–5:30 p. m.	150–200	5		do	Farm buildings wrecked; path 28 miles long.	Do.
Iola, Kans. (4 miles west)	15	5:30 p. m.				do	Small buildings and telephone poles blown down.	Do.

Severe local storms, November, 1930—Continued

[The table herewith contains such data as have been received concerning severe local storms that occurred during the month. A more complete statement will appear in the Annual Report of the Chief of Bureau]

Place	Date	Time	Width of path, yards	Loss of life	Value of property destroyed	Character of storm	Remarks	Authority
Hicksbaugh to Reganville, Tex.	15				50,000	Tornado	Houses unroofed or moved from foundations; service station demolished; 10 persons injured.	Official, U. S. Weather Bureau.
Darington to northwest Lincoln County, Miss.	15-16	10 p. m.-1 a. m.	880	1	50,000	do	Character of damage not reported; 15 persons injured.	Do.
Fern Springs to Noxubee County, Miss.	15-16		200		15,000	do	Character of damage not reported; 11 persons injured.	Do.
Paw Paw, Mich	16					Winds	Large barn wrecked; several farm buildings damaged.	Do.
Rockport, Ind. (7 miles west).	16				5,000	Tornadic wind	Trees uprooted; farm buildings and overhead wires damaged.	Do.
Minnesota (northwestern)	16					Ice	Overhead wires considerably damaged.	Do.
Wisconsin (southeastern)	16				2,000	Wind	Considerable minor damage to boats and other property.	Do.
North Dakota, South Dakota, and northwestern Minnesota.	16					Sleet	Wire lines snapped; highway and rail traffic interrupted, considerable damage in Fargo and Moorhead.	Do.
New Mexico (southwestern).	17-19					Snow and wind	No details.	Do.
New Mexico (northeastern).	18-19			2		do	Some loss of sheep, cattle, and poultry	Do.
Colorado (east of Continental Divide).	18-20			9		Blizzard	Much livestock lost; extensive property damage; highways impassable for several days.	Do.
Bethany, Okla., and vicinity.	19	9.30-9.58 a. m.	25-150	23	250,000	Tornado	About one-fourth of town of Bethany demolished; many houses, barns, and outbuildings completely wrecked; 77 persons seriously injured; path 7 miles long.	Do.
Carrier, Okla.	19	10 a. m.	250		20,000	do	Minor property damage; 4 persons injured	Do.
Victoria, Kans. (near)	19	10.15 a. m.			20,000	do	Schoolhouse demolished; farm buildings damaged; 15 persons injured.	Do.
Neal, Kans., and vicinity	19	2 p. m.	200		15,000	do	7 buildings blown down; several residences damaged; 2 persons injured; path 7.5 miles long.	Do.
Leanna, Kans.	19	2.30 p. m.	100		12,500	do	Several residences, a church, and farm buildings damaged; path 3.5 miles long.	Do.
Valley Falls, Kans	19	4 p. m.			500	Tornadic wind	Radio tower blown down; farm buildings damaged.	Do.
Ola, Ark	19	8.40 p. m.	300	1	230,800	Tornado	Character of damage not reported; 12 injured	Do.
Cleveland, Ark	19	10 p. m.	60		6,000	do	Character of damage not reported	Do.
Courtland, Kans.	19	P. m.			2,000	Wind	Barns unroofed; small buildings lifted from foundations.	Do.
Marlow, Okla. (north of)	19		100		500	Tornado	Minor property damage; path 1 mile long	Do.
Minnesota (northwestern)	19					Ice	Overhead wires damaged	Do.
Nebraska (northern and western).	19-20					Sleet	Considerable damage to telephone and telegraph lines; wire communication suspended for several days.	Do.
North Dakota (southwestern).	19-20					Wind, snow, and sleet.	Chief damage to telephone and telegraph poles and wires; highways blocked.	Do.
Charles Mix County north to Faulk County to east border of the State, S. Dak.	19-20				400,000	Ice	Heavy damage to wires	Do.
Manilla, Iowa	20	3.30 a. m.				Tornado	Character of damage not reported	Do.
Los Angeles, Calif.	22					Wind	Considerable damage to trees and roofs	Do.
Maryville, Mo.	25					do	Some damage to telephone and telegraph poles	Do.
Nebraska (southeastern)	25					do	Many poles broken off; buildings damaged at scattered points.	Do.
Illinois (northern and central).	29	A. m.				Ice	Highway traffic difficult and dangerous, much delay; several persons injured.	Do.

RIVERS AND FLOODS

NOTE.—Due to the absence of complete reports at this time, the November description of rivers and floods will be included in the December issue of the REVIEW.—*Editor.*

WEATHER OF THE ATLANTIC AND PACIFIC OCEANS

NORTH ATLANTIC OCEAN

By F. A. YOUNG

Judging from reports received, the number of days with gales over the northern part of the ocean was not far from the normal, although north of the thirty-fifth parallel these gales were unusually well distributed. As will be shown later, a number of rather unusual disturbances also occurred in southern waters.

According to press reports, winds of hurricane force swept the Panama plantation in the Laceiba zone on the 8th, destroying 58,000 banana trees besides demolishing a number of buildings. This storm must have been extremely local in character, as no reports have as yet been received from vessels involved. On the 7th the American five-masted schooner *Dunham Wheeler* ran into a heavy gale off Cape Canaveral, on the east coast of Florida, and on the following day the crew were obliged to abandon ship, but were rescued by the American steamship *Aztec*. This gale was a "norther," as on the 8th the barometer reading at Norfolk was 30.70 inches and at Kingston, 29.92 inches, with northeasterly gales along the Florida coast.

The number of days on which fog was reported in different localities is as follows: Over the Grand Banks, from 5 to 7 days; along the American coast between the thirty-fifth and forty-fifth parallels, from 5 to 10 days; over the steamer lanes east of the thirty-fifth meridian, from 3 to 7 days; in the Gulf of Mexico, on 3 days.

TABLE 1.—*Averages, departures and extremes of atmospheric pressure at sea level, 8 a. m. (seventy-fifth meridian). North Atlantic Ocean, November, 1930.*

Stations	Average pressure	Departure	Highest	Date	Lowest	Date
	Inches	*Inch*	*Inches*		*Inches*	
Julianehaab, Greenland	29.62	(1)	30.20	15th [2]	28.90	24th.
Belle Isle, Newfoundland	29.89	[3]+0.01	30.36	12th	29.06	26th.
Halifax, Nova Scotia	30.14	[4]+0.19	30.62	4th	29.34	27th.
Nantucket	30.17	[4]+0.15	30.74	29th	29.26	25th.
Hatteras	30.19	[4]+0.12	30.76	29th	29.58	25th.
Key West	30.09	[4]+0.04	30.28	28th [2]	29.96	16th.
New Orleans	30.16	[4]+0.01	30.58	1st	29.76	16th. [2]
Cape Gracias, Nicaragua	29.92	[3]+0.02	29.98	6th [2]	29.84	3d.
Turks Island	30.05	[4]+0.06	30.18	29th	29.94	3d. [2]
Bermuda	30.14	[4]+0.06	30.56	30th	29.86	5th.
Horta, Azores	30.19	[3]+0.09	30.58	6th [2]	29.70	20th
Lerwick, Shetland Islands	29.58	[3]−0.12	30.25	17th	28.87	26th.
Valencia, Ireland	29.81	[3]−0.08	30.75	11th	28.84	2d.
London	29.85	[3]−0.09	30.72	12th	28.92	2d.

[1] No normal available.
[2] And on other date or dates.
[3] From normals shown on Hydrographic Office Pilot Charts, based on observations at Greenwich mean noon, or 7 a. m., seventy-fifth meridian time.
[4] From normals based on 8 a. m. observations.

Charts VIII to XI cover the period from the 2d to 5th, inclusive, and show the disturbance off the American coast as well as that in the vicinity of Europe.

On the 6th the European LOW was central in the English Channel, and westerly gales prevailed as far west as the twentieth meridian. On the same day Father Point, Quebec, was also near the center of a depression and winds of force 7 and 8 were reported by vessels between the thirty-fifth and forty-seventh parallels. On the 7th conditions similar to those of the previous day prevailed off the coasts of Canada and New England, while on the 7th as well as the 8th the "norther" previously referred to, was in southern waters.

On the 8th westerly gales occurred over the middle section of the northern steamer lanes, while on the 9th and 10th comparatively moderate weather was the rule over the greater part of the ocean.

From the 11th to 16th there ensued a period of heavy weather that reached its greatest intensity on the 13th and 14th when the storm area covered the region from the thirty-fifth to forty-fifth parallels and thirty-fifth to fifty-fifth meridians, where winds of hurricane force were reported by a number of vessels. By the 16th this disturbance had decreased in intensity, although moderate to strong gales were still encountered in the northern steamer lanes.

From the 19th to 23d comparatively low pressure occurred over the region usually covered by the North Atlantic HIGH, the barometer at Horta reaching its minimum reading of 29.70 inches on the 20th, when the center of this LOW area was near 50° N., 32° W. The LOW moved slowly eastward, accompanied by moderate to strong gales, and on the 22d was over the North Sea, with barometric readings of from 28.80 to 28.94 inches reported by stations on the east coasts of England and Scotland.

On the 23d a LOW was central near Belle Isle, Newfoundland, and a second near 55° N., 28° W. From that date until the 26th winds of gale force prevailed over the middle and eastern sections of the steamer lanes.

On the 25th Nantucket was near the center of a depression, and while moderate weather was reported at time of observation near the center, the region between the thirtieth and thirty-fifth parallels was swept by strong westerly gales with a comparatively uniform increase in barometer readings from the fortieth to thirtieth parallels. On the 26th the center was near Father Point, where the barometer reading was 28.88 inches, and westerly gales were still reported from the vicinity of Hatteras, while moderate conditions prevailed over the region between these two points.

By the 27th this LOW had apparently begun to fill in, while there were indications of a secondary forming about halfway between the Bermudas and Nantucket, although it was impossible to determine the position accurately, due to lack of observations. On this day the storm area covered the greater part of the region between the thirtieth and fortieth parallels, and the fifty-fifth and seventy-fifth meridians.

From the 28th to 30th northeast trades of force 7 and 8 were reported by vessels near the east coast of Cuba.

On the 29th westerly to northwesterly gales, accompanied by comparatively high pressure, occurred between the Bermudas and Nova Scotia, and on the 30th between the fortieth meridian and east coast of Newfoundland.

OCEAN GALES AND STORMS, NOVEMBER, 1930

Vessel	Voyage		Position at time of lowest barometer		Gale began	Time of lowest barometer	Gale ended	Lowest barometer	Direction of wind when gale began	Direction and force of wind at time of lowest barometer	Direction of wind when gale ended	Highest force of wind and direction	Shifts of wind near time of lowest barometer
	From—	To—	Latitude	Longitude									
NORTH ATLANTIC OCEAN			° ′	° ′		*Nov.*		*Inches*					
Sagaporack, Am. S. S.	New York	Copenhagen	58 27 N	27 00 W	Oct. 31	8 p., 1	Nov. 2	28.63	S	NE, 11	N	—, 11	S-E-N.
San Benito, Br. S. S.	Castilla	Boston	16 10 N	86 54 W	Nov. 2	11 a., 2	do	29.90	W	W, 9	W	W, 9	Steady.
Gonzenheim, Ger. S. S.	Newcastle-on-Tyne.	Baltimore	35 47 N	65 32 W	do	4 a., 2	do	29.97	NE	W, 3	NNE	N, 10	W-N.
Hoflaan, Du. S. S.	Rosario	Hull	43 27 N	9 04 W	do	—, 2	Nov. 4	29.61	SW	SW, 10	NW	NW, 12	SW-NW.
San Macedonio, Br. S. S.	River Humber.	Mexico	48 30 N	11 00 W	Nov. 1	8 a., 2	Nov. 5	29.41	SW	W, 9	N	NW, 11	WSW-NW.
Hastings, Am. S. S.	Pensacola	Bremen	36 32 N	67 41 W	Nov. 3	10 p., 3	Nov. 4	29.95	E	E, 7	S	—, 10	E-SE-S.
Georgia, Dan. S. S.	Norfolk	Rotterdam	49 36 N	12 40 W	Nov. 2	Noon, 3	Nov. 3	29.33	W	NNW, 10	NW	—, 11	Steady.
Aquitania, Br. S. S.	Southampton	New York	48 51 N	28 54 W	Nov. 4	6 a., 4	Nov. 4	29.26	S	WSW, 12	NW	WSW, 12	WSW-WNW.
Henri Jaspar, Belg. S. S.	Antwerp	do	50 52 N	24 00 W	Nov. 1	2 p., 4	Nov. 5	28.75	SW	W, 10	NW	NNW, 12	WSW-W-NNW
Lotte Leonhardt, Ger. S. S.	Ardrossan	Tampico	44 00 N	12 30 W	Nov. 5	—, 5	Nov. 6	29.81	W	W, 11	NNW	—, 11	W-NW.
Sneaton, Br. S. S.	St. Vincent	Rotterdam	49 02 N	4 39 W	do	Noon, 5	do	29.32	S	SSE, —	NE	NE, 10	SSE-ESE.
Bellflower, Am. S. S.	Liverpool	Boston	42 47 N	66 30 W	Nov. 6	Noon, 6	Nov. 7	29.57	WSW	WSW, 9	NW	W, 10	W-NW.
Marie Leonhardt, Ger. S. S.	Norfolk	Murmansk	62 05 N	5 56 W	Nov. 7	—, 7	Nov. 8	28.72	SW	SW, 8	W	—, 11	WSW-WNW.
Valcerusa, Ital. S. S.	Montreal	Genoa	35 56 N	5 47 W	do	Noon, 7	Nov. 9	30.04	E	E, 6	ENE	E, 9	Steady.
City of Joliet, Am. S. S.	New Orleans	Havre	40 25 N	54 00 W	Nov. 10	11 p., 10	Nov. 15	29.38	NNW	NNW, 7	WNW	N, 12	N-NNW.
Boschdijk, Du. S. S.	Port Said	Boston	43 26 N	46 29 W	do	4 p., 11	Nov. 12	29.61	SSE	S, 9	NNE	S, 10	
Nessian, Br. S. S.	Swansea	Montreal	54 00 N	33 05 W	Nov. 11	6 p., 11	Nov. 11	29.57	S	S, 9	NW	S, 10	S-W-NW.
Dresden, Ger. S. S.	Cobh	New York	44 50 N	45 38 W	Nov. 12	—, 12	Nov. 14	29.84	NE	NE, 10	NNE	NE, 10	NE-NNE.
Lotte Leonhardt, Ger. S. S.	Ardrossan	Tampico	35 34 N	41 50 W	do	—, 13	Nov. 15	29.63	S	WSW, 11	W	SW, 12	
Murex, Br. S. S.	Rouen	Key West	36 24 N	40 45 W	do	10 p., 13	Nov. 14	29.14	S	SSW, 11	WSW	SSW, 12	Steady.
Conte Grande, Ital. S. S.	Gibraltar	New York	37 53 N	41 30 W	Nov. 13	2 a., 14	do	28.78	SSE	NW, 10	NW	SSE, 12	
Aden Maru, Jap. S. S.	Glasgow	Norfolk	44 03 N	39 31 W	Nov. 14	Noon, 15	Nov. 17	28.91	S	N, 10	W	W, 11	ESE-E-N.
Jalapa, Am. S. S.	Boston	Manchester	54 11 N	27 20 W	Nov. 16	4 p., 16	Nov. 16	29.56	E	E, 12	SSE	E, 12	ESE-SSE.
Natirar, Am. S. S.	Bremen	Boston	47 42 N	36 04 W	Nov. 19	11 p., 19	Nov. 22	29.18	NNW	NNW, 7	NW	NW, 10	SW-W-NW

Ocean gales and storms, November, 1930—Continued

Vessel	Voyage		Position at time of lowest barometer		Gale began	Time of lowest barometer	Gale ended	Lowest barometer	Direction of wind when gale began	Direction and force of wind at time of lowest barometer	Direction of wind when gale ended	Highest force of wind and direction	Shifts of wind near time of lowest barometer
	From—	To—	Latitude	Longitude									
NORTH ATLANTIC OCEAN—Continued			° ′	° ′				*Inches*					
						Nov.							
Ambridge, Am. S. S.	Antwerp	New York	49 31 N	40 01 W	Nov. 22	Mdt, 22	Nov. 24	29.50	NW	NW, 10	WNW	W, 10	W-WNW.
Tiger, Nor. S. S.	Oslo	do	57 00 N	23 40 W	Nov. 23	8 p., 23	do	28.91	S	WSW, 9	W	WSW, 10	SSW-WSW.
Japan Arrow, Am. S. S.	New York	Canal Zone	37 45 N	73 41 W	Nov. 25	8 a., 25	Nov. 27	29.41	W	W, 7	WNW	W, 11	Steady.
Examalia, Am. S. S.	Gibraltar	New York	36 58 N	56 45 W	Nov. 26	6 p., 26	Nov. 29	29.72	S	S, 10	N	—, 10	S-SW-W.
Canadian Leader, Br. S. S.	Canal Zone	Boston	17 51 N	75 08 W	Nov. 28	6 a., 28	Nov. 30	29.88	NE	NE, 7	E	NE, 8	Steady.
W. C. Teagle, Am. S. S.	Aransas Pass	do	27 26 N	94 26 W	do	4 p., 29	Nov. 29	30.00	SE	SE, 8	SE	SE, 8	Do.
Tiger, Nor. S. S.	Oslo	New York	48 58 N	47 48 W	Nov. 29	7 p., 29	Nov. 30	29.25	NNE	NE, 11	NW	NE, 12	NE-NW.
Bremen, Ger. S. S.	Cherbourg	do	47 22 N	36 25 W	do	8 p., 29	do	29.52	SSW	SW, 7	WNW	—, 11	
Ninian, Br. S. S.	Liverpool	Boston	50 00 N	45 23 W	do	11 p., 29	Dec. 3	29.01	NW	N, —	WNW	NW, 12	N-W-SW.
NORTH PACIFIC OCEAN													
Petricola, Br. S. S.	Saito Zaki	San Francisco	40 05 N	153 40 E	Oct. 31	4 a, 1	Nov. 1	29.37	NNE	S, 4	NNE	NNE, 9	S-NNE.
San Julian, Am. S. S.	San Pedro	Balboa	16 00 N	94 50 W	do	4 p, 1	Nov. 2	29.91	NNE	NNW, 9	N	NNW, 10	N-NW-N.
						Oct.							
Broad Arrow, Am. S. S.	San Pedro	do	14 23 N	97 18 W	do	Mdt., 31	Nov. 4	29.96	NNE	ENE, —	N	NE, 10	Steady.
						Nov.							
Admiral Farragut, Am. S. S.	Seattle	Kodiak	59 00 N	152 00 W	Nov. 1	6 a, 1	Nov. 1	29.64	NW	NW, 9	NW	NW, 9	Do.
Starr, Am. S. S.	Seward	Aleutian Is.	53 50 N	167 20 W	do	4 p, 1	Nov. 2	29.14	SE	SE, 8	S	SE, 9	
Chief Capilano, Br. S. S.	Shanghai	Vancouver	48 00 N	173 00 E	do	4 a, 2	Nov. 3	29.24	SSE	W, 6	N	W, 11	S-SW-W.
California, Am. S. S.	Columbia R.	Shanghai	50 30 N	178 45 E	Nov. 2	10 a, 2	do	29.15	S	SW, 8	WNW	WNW, 11	SW-WNW.
Admiral Farragut, Am. S. S.	Kodiak	Seattle	59 06 N	150 50 W	Nov. 4	10 p, 5	Nov. 5	28.91	NE	NE, 10	E	NE, 12	NE-E-SE.
Tacoma, Am. S. S.	Tacoma	Yokohama	50 45 N	136 30 W	do	—, 6	Nov. 6	29.37	ESE	ESE, 5	WSW	SW, 10	
Olympia Maru, Jap. M. S.	Yokohama	Seattle	45 46 N	174 21 E	Nov. 7	Noon, 7	Nov. 8	29.23	W	W, 7	NW	WNW, 10	W-NW.
Maliko, Am. S. S.	Puget Sound	Hawaiian Is.	48 20 N	123 00 W	Nov. 8	7 a, 8	do	29.72	SSE	SSE, 8	SW	SSE, 8	SSE-S.
Chief Capilano, Br. S. S.	Shanghai	Vancouver	49 45 N	138 36 W	Nov. 9	6 p, 9	Nov. 10	29.20	SSW	SSW, 7	W	WSW, 9	SE-S-SSW.
Pres. Garfield, Am. S. S.	San Francisco	Kobe	26 56 N	170 30 W	Nov. 10	1 a, 10	Nov. 11	29.88	N	N, 7	NE	N, 9	WSW-N.
Dalblair, Br. S. S.	Vancouver	Shanghai	50 03 N	178 42 E	do	4 p, 12	Nov. 12	29.30	S	SSE, 8	NE	S, 10	S-SSE-NE.
San Pedro Maru, Jap. S. S.	Yokohama	San Francisco	39 00 N	161 42 W	do	Noon, 11	do	30.19	NE	NE, 9	SE	NE, 9	NE-ENE.
Columbia Maru, Jap. S. S.	Vancouver	Yokohama	51 45 N	168 55 W	Nov. 11	6 a, 13	Nov. 13	29.68		SW, —	W	SSW, 10	SSW-SW.
Tacoma, Am. S. S.	Tacoma	do	50 30 N	171 24 W	do	4 p, 12	Nov. 14	29.39	SSW	SW, 10	W	S, 10	S-SW-WSW.
Pres. Taft, Am. S. S.	Puget Sound	do	41 11 N	148 42 E	Nov. 12	Noon, 12	Nov. 12	29.47	WNW	WNW, 7	W	W, 10	Steady.
Golden Tide, Am. S. S.	Hong Kong	San Francisco	43 31 N	136 45 W	Nov. 14	Mdt, 15	Nov. 16	29.80	W	NW, 10	NNW	NW, 10	W-NNW.
Dalblair, Br. S. S.	Vancouver	Shanghai	45 40 N	156 22 E	Nov. 17	10 p, 17	Nov. 18	29.38	SSE	W, 11	WNW	WNW, 12	SSE-N.
Ayaba Maru, Jap. S. S.	Miike	Tacoma	44 50 N	161 10 E	do	3 p, 18	Nov. 19	29.51	SE	W, 10	WNW	W, 11	1 pt.
Starr, Am. S. S.	Seward	Aleutian Is.	58 56 N	152 25 W	do	2 p, 17	do	28.40	NE	NE, 7	W	NE, 10	
Manila Maru, Jap. S. S.	Yokohama	Vancouver	45 50 N	165 30 E	Nov. 18	8 p, 18	do	29.44	W	W, 10	WNW	W, 10	W-NW-NNW
Tyndareus, Br. S. S.	Yokohama	Victoria	39 44 N	150 57 E	Nov. 20	Mdt., 21	Nov. 22	29.60	SE	SSE, 8	SW	SSE, 9	SSE-S.
Do	do	do	50 03 N	167 20 W	Nov. 24	10 p, 26	Nov. 27	28.55	SSE	S, 9	SE	E, 9	E-SE-S.
Dalblair, Br. S. S.	Victoria	Shanghai	41 40 N	142 38 E	Nov. 21	10 p, 21	Nov. 22	29.50	W	W, 10	W	W, 10	Steady.
Pres. Madison, Am. S. S.	Yokohama	Seattle	49 50 N	156 45 W	Nov. 22	2 p, 25	Nov. 25	29.60	SSE	NW, 7	W	NNE, 9	NNW-W.
San Anselmo, Am. S. S.	Newport News.	Los Angeles	15 16 N	93 35 W	Nov. 27	10 a, 27	Nov. 27	29.91	NNW	NNW, —	NW	NNW, 9	Steady.
Admiral Farragut, Am. S. S.	Seattle	Kodiak	58 29 N	152 35 W	Nov. 28	—, 28	Nov. 30	29.59	NNE	NNE, 6	NE	NE, 9	Do.
SOUTH PACIFIC OCEAN													
Lina L. D., Fr. S. S.	San Pedro	Port Pirie	35 32 S	138 16 E	Nov. 3	Noon, 3	Nov. 4	29.41	NNE		WSW	WSW, 12	

NORTH PACIFIC OCEAN

By WILLIS E. HURD

Atmospheric pressure.—Pressure over the most of the North Pacific Ocean in November did not change very materially from that of October, on the average, except over the western waters of the Gulf of Alsaka, where there was a considerable fall. Whereas in the previous month the Aleutian LOW stretched as a shallow depression from the Gulf far westward into the Bering Sea, in November it was centered as a fairly energetic cyclone near Kodiak, where the average pressure was 29.44 inches, or a tenth of an inch below the normal. At other points in the Gulf of Alaska and in the Bering Sea, as shown by Table 1, the average pressures were slightly above the normal.

The North Pacific anticyclone persisted practically throughout the month over the eastern part of the ocean in middle latitudes. Along the central meridians high pressure was occasionally displaced by moderate depressions during the first two decades, and prevailingly so throughout the last of the month. Anticyclonic conditions for the most part overspread the western waters of the ocean between latitudes 20° and 40° N., though interspersed by occasional and rather unimportant depressions between Guam and the Asiatic mainland.

The following table gives the principal barometric data for several island and coast stations in west longitudes.

TABLE 1.—*Averages, departures, and extremes of atmospheric pressure at sea level at indicated hours, North Pacific Ocean and adjacent waters, November, 1930*

Stations	Average pressure	Departure from normal	Highest	Date	Lowest	Date
	Inches	*Inch*	*Inches*		*Inches*	
Point Barrow [1]	30.08		30.76	3d	29.16	14th
Dutch Harbor [1]	29.65	+0.06	30.34	24th	29.04	17th
St. Paul [1 2]	29.71	+0.09	30.58	24th	28.92	13th
Kodiak [1]	29.44	−0.10	30.42	12th	28.30	18th
Midway Island [1]	30.06	+0.01	30.26	18th	29.80	30th
Honolulu [3]	29.96	−0.06	30.12	13th	29.76	25th
Juneau [3]	29.79	+0.03	30.74	22d	28.63	15th
Tatoosh Island [3 4]	30.08	+0.11	30.72	21st	29.01	15th
San Francisco [3 4]	30.08	−0.02	30.41	20th	29.68	16th
San Diego [3 4]	30.01	+0.01	30.27	20th	29.75	13th

[1] P. m. for average; a. m. and p. m. for extremes.
[2] For 29 days.
[3] A. m. and p. m. observations.
[4] Corrected to 24-hour mean.

Cyclones and gales.—There were at least four major progressive cyclones which occurred in November on the North Pacific. The earliest was that which originated on October 29 over eastern China, and caused severe gales on the 31st, east of Japan. On November 1 this storm was apparently of lessened intensity, with reported winds not exceeding 9 in force, near the fortieth parallel, between 145° and 155° east longitude. On the 2d and 3d, however, as it entered the Aleutian region and intensified the LOW already existent there, rougher weather resulted, with gales of force 11 reported from near latitude 50° N., between longitudes 170° E. and 180°. On the 3d and 4th it moved rapidly into the Gulf of Alaska, where it remained as an oscillating disturbance until about the 10th.

The second cyclone was that of the 9th to 12th which came out of Asia below Vladivostock and died out in the eastern part of the Bering Sea. This storm, however, inasmuch as it traversed a northerly region across the Sea of Okhotsk and Kamchatka, did not seriously affect any shipping along the trans-Pacific routes.

The third cyclone crossed the Yellow Sea from China on the 15th, and the Japan Sea and northern Japan on the 16th. On the 17th, when central south of the Kuril Islands, although then apparently of no great barometric depth, it was productive of hurricane velocities, as indicated by the report of the steamship *Ayaha Maru*, and on the 18th, farther eastward, by gales of full storm force. On the 19th and 20th the cyclone greatly intensified the Aleutian LOW over the eastern part of the Bering Sea and the upper waters of the Gulf of Alaska, and on the following day was central, diminishing, in the Canadian Northwest.

The fourth major traveling cyclone, although shorter in extent of water area traversed, was by no means unimportant. It probably originated on the 16th or 17th as a minor Aleutian disturbance west of the Peninsula of Alaska. On the 18th it had become a powerful cyclone in the Gulf of Alaska, with the barometer at Kodiak falling to its minimum of the month, 28.30 inches. This cyclone moved northward during the 19th and 20th, after which it no longer affected the sea. During its passage of the western part of the gulf it caused high winds, with a maximum recorded force of 11 on the 18th, over a considerable region. The period of great storm intensity, 17th to 19th, south of Alaska, was the heaviest of the month, and during its continuance two distinct and progressive cyclone centers passed over the island of Kodiak.

A traveling cyclone of much less intensity than the foregoing originated near the Hawaiian Islands about the 22d and was central over the northern extremity of the Gulf of Alaska on the 27th, after a passage between two extensive Pacific anticyclones. A few gales, with maximum reported force of 9, attended its northward course.

The month as a whole was little if any stormier than October, the varying degrees of storminess between the months being mostly local. There were fewer days with severe weather in the waters east of Japan, maximum velocities of force 10 east of Hondo and Yezo on the 12th, 21st, and 22d occurring instead of the storm and hurricane velocities of October 26 to 31. In general, south of the Aleutians, although the number of days with gales was probably not greater than in October, the winds were of somewhat higher force, owing to the greater intensity of the LOWS, forces 9 and 10 being about as frequent this month as were the forces of 8 in the previous month. Their numbers may be determined by reference to Table 1. Between Kodiak and the mainland to the northward hurricane winds from the northeast occurred on the 5th. Scattered strong to whole gales were experienced east of Midway Island on the 10th, and at some distance off the California coast on the 15th and 16th, the latter resulting from cyclonic activity extending far southward from Alaskan waters.

Few high wind velocities occurred except locally within the tropics. A fresh northeast gale was experienced east of the Mariannas on the 8th, in connection with a disturbance of low latitudes that also caused fresh gales ten degrees to the northward on the 11th. To the southeastward of the Hawaiian Islands fresh east and northeast gales on the 13th and 14th indicated merely a strengthening of the trades due to intensified high pressure gradients.

Over and south of the Gulf of Tehuantepec fresh to strong or whole gales blowing as northers, due to strong anticyclones extending southward from the United States, occurred from the 1st to 6th, and on the 23d, 24th, and 27th.

At Honolulu the prevailing direction of the wind continued from the east, with a maximum velocity of 28 miles an hour from the same direction on the 16th.

Fog.—The number of days with fog in November lessened appreciably in most localities over the number in October. There were widely separated occurrences of fog on six days, as reported from upper east longitudes, and approximately the same number in upper and central waters of west longitudes. In no part of the ocean away from the coasts was fog reported on more than three days for a given locality. The frequency was somewhat greater along the American coast, and between Eureka and central Lower California fog was encountered on from six to eight days.

TYPHOONS AND DEPRESSIONS

A VERY SMALL TYPHOON OVER THE VISAYAN ISLANDS, NOVEMBER 2 TO 3, 1930

By Rev. José Coronas, S. J.

Weather Bureau, Manila, P. I.

After two months of an extraordinary absence of typhoons, the Philippines were suddenly visited by a very small typhoon during the night of November 2 to 3. Because of its small diameter and of its great rate of progress, the typhoon entered the Archipelago without giving sufficient time for any warning. The center entered the eastern coast of southern Samar at about 9 p. m. of the 2d; it passed close to Tacloban at about 11 p. m.; and, after traversing the northern part of Leyte, Cebu, and Negros Islands, it passed very near to Iloilo at about 5.30 a. m. of November 3. The typhoon moved from Leyte to Iloilo at the extraordinary rate of over 22 miles per hour. With the exception of the portion of the track between Tacloban and Ormoc, the direction of the typhoon was West by South.

Although the depth of the typhoon was not very great, yet much damage was done to several towns, specially to those on the north side of the track owing to the considerable force obtained by the northerly winds prevailing during this part of the year. Thousands of people were homeless after the storm, particularly in the Province of Iloilo.

Press dispatches reported heavy loss of life and severe damage caused by a typhoon at the beginning of November (probably on the 5th or during the night of the 4th to 5th) at Pulo Condore, an island off the Cochin-China coast. There is no doubt that it was the same typhoon that had struck the Philippines on November 2 to 3 and continued following a West by South direction across the China Sea.

The approximate positions of the typhoon on November 1 to 5 were:

November 2, 9 p. m., 125° 40′ longitude E., 11° 20′ latitude N.
November 2, 11 p. m., 125° 05′ longitude E., 11° 15′ latitude N.
November 3, 0.30 a. m., 124° 30′ longitude E., 10° 55′ latitude N.
November 3, 6 a. m., 121° 55′ longitude E., 10° 30′ latitude N.
November 3, 2 p. m., 120° 00′ longitude E., 10° 15′ latitude N.
November 4, 6 a. m., 115° 15′ longitude E., 9° 45′ latitude N.
November 5, 6 a. m., 108° 45′ longitude E., 9° 05′ latitude N.

CLIMATOLOGICAL TABLES

[For description of tables and charts, see REVIEW, January, 1930, p. 37]

CONDENSED CLIMATOLOGICAL SUMMARY

In the following table are given for the various sections of the climatological service of the Weather Bureau the monthly average temperature and total rainfall; the stations reporting the highest and lowest temperatures, with dates of occurrence; the stations reporting the greatest and least total precipitation; and other data as indicated by the several headings.

The mean temperature for each section, the highest and lowest temperatures, the average precipitation, and the greatest and least monthly amounts are found by using all trustworthy records available.

The mean departures from normal temperatures and precipitation are based only on records from stations that have 10 or more years of observations. Of course, the number of such records is smaller than the total number of stations.

Condensed climatological summary of temperature and precipitation by sections, November, 1930

Section	Temperature								Precipitation					
			Monthly extremes								Greatest monthly		Least monthly	
	Section average	Departure from the normal	Station	Highest	Date	Station	Lowest	Date	Section average	Departure from the normal	Station	Amount	Station	Amount
	°F.	°F.		°F.			°F.		In.	In.		In.		In.
Alabama	53.9	−0.2	2 stations	85	[1] 17	Valley Head	16	26	7.18	+4.10	Troy No. 1	16.39	Demopolis	3.68
Arizona	51.0	−1.5	do	95	[1] 1	Ganado	−6	20	1.80	+1.07	Pinal Ranch	6.53	2 stations	0.00
Arkansas	50.5	−1.1	Pine Bluff	87	18	2 stations	16	[1] 6	4.15	+0.50	Norman	9.35	Wilson	1.95
California	51.9	+0.4	3 stations	98	[1] 1	do	−6	[1] 14	2.39	−0.08	Lake Spaulding	9.50	Greenland Ranch	0.00
Colorado	33.0	−2.0	Eads	82	[1] 5	Dillon	−24	22	1.40	+0.51	La Veta Pass	8.25	Garnett	0.12
Florida	64.1	−1.0	Brooksville	91	18	Garniers (near)	21	27	3.47	+1.24	De Funiak Springs	16.28	Bradenton	0.09
Georgia	53.3	−1.2	Millen	86	18	Clayton	10	27	5.74	+3.09	Americus	10.63	Glennville	2.79
Idaho	31.0	−4.6	Glenns Ferry	76	7	Deadwood	−20	19	1.53	−0.63	Roland	4.52	Salmon	0.14
Illinois	43.5	+1.4	Harrisburg	83	19	2 stations	−11	28	2.16	−0.24	Quincy	4.43	Danville	0.79
Indiana	43.2	+1.0	Washington	82	19	Wheatfield	−9	28	1.98	−1.11	South Bend	3.50	Princeton	0.71
Iowa	41.3	+4.7	Clinton	79	19	Decorah	−16	28	2.12	+0.57	Centerville	4.57	Dubuque	0.79
Kansas	45.0	+1.1	Richfield	85	14	Colby	8	22	2.43	+1.21	Leavenworth	4.69	Hugoton	0.35
Kentucky	47.1	+0.7	Murray	86	19	Mount Sterling	−4	27	1.82	−1.75	2 stations	3.69	Maysville	0.81
Louisiana	58.5	−0.4	Dalcour	90	17	3 stations	22	27	6.11	+2.53	Port Eads	9.57	Covington	3.03
Maryland-Delaware	44.9	+0.3	Western Port, Md.	75	18	Oakland, Md	−16	29	1.28	−1.26	Millsboro, Del	2.72	Chewsville, Md	0.48
Michigan	39.3	+2.9	Eau Claire	79	20	Wolverine	−17	28	1.55	−0.82	Eau Claire	4.46	Owosso	0.24
Minnesota	32.4	+2.8	Beardsley	74	10	Itasca State Park	−28	28	2.46	+1.38	Pigeon River Bridge	7.10	Faribault	0.52
Mississippi	55.2	+0.1	Leakesville	89	17	2 stations	20	[1] 27	6.35	+2.79	Columbia	10.72	Austin	2.82
Missouri	45.8	+1.4	Doniphan	83	18	4 stations	8	28	2.93	+0.53	Lamonte	6.10	Doniphan	1.27
Montana	31.6	−0.3	3 stations	75	[1] 1	2 stations	−20	[1] 15	0.86	−0.03	Heron	5.00	2 stations	0.09
Nebraska	39.1	+2.4	Wakefield	79	14	Gordon	5	24	1.91	+1.12	Seward	3.47	Sheep Creek Camp	0.15
Nevada	38.7	−2.6	2 stations	89	3	San Jacinto	−16	15	1.21	+0.53	Lewers Ranch	5.13	3 stations	0.00
New England	39.4	+1.5	Weston, Mass	72	22	Keene "B", N. H.	−10	29	3.54	+0.06	Milford, Conn	7.31	Danforth, Me	1.28
New Jersey	44.1	+1.3	Belleplain	73	15	Charlotteburg	2	29	3.70	+0.52	Bayonne	6.54	Northfield	1.41
New Mexico	40.0	−2.1	Clovis	78	3	2 stations	14	[1] 22	0.93	+0.28	Cloudcroft	2.86	Vance (near)	0.05
New York	41.0	+3.2	Cairo	77	22	do	−13	29	2.34	−0.68	Setauket	7.13	Dansville	0.39
North Carolina	47.9	−1.6	2 stations	82	18	Mount Mitchell	−13	27	3.28	+0.72	Highlands	8.11	Rocky Mount	1.14
North Dakota	29.4	+2.8	do	72	[1] 3	Drake	−21	30	0.87	+0.29	Grand Forks	3.09	3 stations	T.
Ohio	42.6	+1.0	Circleville	80	19	5 stations	−4	[1] 27	1.55	−1.22	Phalanx	3.51	Athens	0.49
Oklahoma	50.8	+0.6	Poteau	88	18	2 stations	16	[1] 23	2.24	+0.21	Eufaula	5.14	Hooker	0.20
Oregon	40.0	−1.1	Government Camp	87	21	do	−8	19	2.91	−1.94	Government Camp	9.31	Blitzen	0.10
Pennsylvania	42.0	+1.0	Newell	75	21	Somerset	−15	29	1.48	−1.33	Mount Pocono	4.29	Ansonia	0.22
South Carolina	50.8	−2.9	Trenton	85	18	Caesar's Head	6	27	4.35	+2.02	Caesar's Head	8.67	Charleston	1.23
South Dakota	35.4	+1.9	Flandreau	78	10	Webster	−7	[1] 26	1.27	+0.55	Sioux Falls	2.80	Dowling	0.12
Tennessee	48.5	+0.1	McKenzie	86	19	2 stations	3	[1] 27	3.29	−0.33	Rockwood	6.44	Newbern	1.55
Texas	55.7	−1.4	Falfurrias	94	16	Spearman	17	26	2.72	+0.38	Columbus	8.00	Buena Vista	T.
Utah	31.9	−5.5	Springdale	80	4	Woodruff	−21	20	1.11	+0.13	Silver Lake	3.47	Green River	0.03
Virginia	45.5	−1.0	Pedlar Dam	80	[1] 20	Burkes Garden	−1	27	1.80	−0.53	Rocky Mount	3.62	Fredericksburg	0.66
Washington	37.9	−1.6	Lake Clealum	75	10	Davenport	−2	18	2.91	−2.62	Wynoochee Oxbow	10.97	Sunnyside	0.07
West Virginia	42.3	−0.2	2 stations	80	[1] 18	Bayard	−14	29	1.42	−1.38	Pickens	4.45	Dam 13, Ohio River	0.46
Wisconsin	36.9	+3.3	Marshfield	80	10	Solon Springs	−19	28	1.19	−0.63	Superior	2.77	Sturgeon Bay	0.23
Wyoming	30.5	−0.9	3 stations	72	[1] 3	Riverside	−32	19	0.54	−0.20	Bechler River	3.13	4 stations	0.00
Alaska (October)	29.7	−1.3	Sitka	61	23	White Mountain	−13	29	3.50	−0.38	Port Alexander	31.70	Barrow	0.02
Hawaii	72.9	+1.1	Kaanapali	93	16	Puu Kapele	50	28	13.32	+5.38	Puu Kukui (upper)	45.00	Pahoehoe	0.86
Porto Rico	77.2	+0.4	Fajardo	98	18	Guineo Reservoir	50	19	7.17	−0.25	Rio Blanco	18.67	Coamo	1.03

[1] Other dates also.

TABLE 1.—*Climatological data for Weather Bureau stations, November, 1930*

District and station	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. + mean min. ÷ 2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest daily range	Mean wet thermometer	Mean temperature of the dew-point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with .01, or more	Wind: Total movement	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	*Ft.*	*Ft.*	*In.*	*In.*	*In.*	° *F.*	° *F.*	°*F.*		°*F.*	° *F.*		°*F.*	° *F.*	° *F.*	° *F.*	%	*In.*	*In.*		*Miles*								*0–10*	*In.*	*In.*
New England							**42.0**	**+2.5**										**77**	**3.75**	**+0.5**										**6.1**		
Eastport	76	67	85	30.04	30.13	+0.12	39.8	+3.1	55	9	46	11	29	34	26	37	32	74	1.50	−1.8	9	6,948	sw.	41	s.	30	5	7	18	7.2	4.6	0.0
Greenville, Me.	1,070	6	----	28.92	30.12	------	34.0	------	57	14	42	4	29	27	27	----	----	----	3.47	------	8	4,274	se.	----	----	----	6	9	15	----	3.2	0.0
Portland, Me.	103	82	117	30.04	30.16	+.15	41.2	+3.2	68	14	48	13	29	34	23	36	31	72	3.91	+0.4	8	5,970	sw.	27	sw.	30	11	8	11	5.4	T.	0.0
Concord	289	70	79	29.83	30.16	+.10	39.3	+1.6	66	14	48	7	29	30	33	----	----	----	3.14	+0.1	11	3,239	ne.	22	nw.	6	14	5	11	5.0	T.	0.0
Burlington	403	11	48	29.68	30.13	+.08	39.0	+2.7	61	14	46	4	29	32	26	----	----	----	1.82	−0.8	11	7,632	s.	40	s.	30	5	5	20	7.5	0.4	0.0
Northfield	876	12	60	------	30.15	+.10	36.4	+3.6	62	14	46	−3	29	27	32	----	----	85	2.69	−0.2	8	4,853	s.	27	se.	30	3	7	20	7.8	1.4	0.0
Boston	125	106	165	30.02	30.16	+.11	45.0	+3.0	71	22	52	16	29	38	23	40	35	72	4.09	+0.8	13	5,332	sw.	26	nw.	6	9	10	11	5.7	0.1	0.0
Nantucket	12	14	90	30.14	30.15	+.10	46.4	+2.0	63	14	52	20	29	41	21	43	39	80	7.01	+3.8	12	10,951	sw.	47	sw.	25	8	8	14	6.4	1.6	0.0
Block Island	26	11	46	30.12	30.15	+.09	45.6	+1.0	61	13	50	20	29	41	22	43	40	82	3.51	−0.1	12	11,808	sw.	46	w.	25	5	11	14	6.6	1.4	0.0
Providence	160	215	251	29.98	30.16	+.09	43.6	+3.2	64	22	50	13	29	37	24	40	35	74	3.32	+0.3	12	6,945	nw.	50	nw.	6	12	8	10	5.1	0.1	0.0
Hartford	159	122	----	29.98	30.16	+.08	42.8	+3.3	70	22	51	14	29	35	28	----	----	----	3.51	0.0	12	------	sw.	----	----	----	12	7	11	5.5	T.	0.0
New Haven	106	74	153	30.05	30.17	+.10	43.3	+1.3	62	9	50	14	29	37	22	40	35	74	6.73	+3.4	10	6,496	n.	33	s.	30	11	7	12	5.4	T.	0.0
Middle Atlantic States							**46.0**	**+1.0**										**74**	**2.07**	**−0.5**									**6.3**		
Albany	97	107	115	30.05	30.16	+.08	42.5	+3.2	65	9	50	10	29	35	26	38	33	74	1.90	−0.9	9	4,291	s.	30	se.	30	8	11	11	6.1	0.3	0.0
Binghamton	871	10	84	29.21	30.16	+.07	42.2	+3.5	66	9	50	8	29	35	29	----	----	----	1.06	−1.3	15	4,076	w.	27	sw.	30	5	5	20	7.6	1.0	0.0
New York	314	414	454	29.84	30.18	+.09	45.8	+1.6	64	9	52	16	28	40	27	42	37	75	5.43	+2.5	9	9,775	sw.	48	s.	30	7	8	15	6.6	T.	0.0
Bellefonte	1,050	5	36	29.03	30.16	------	39.4	------	68	18	50	1	29	29	42	35	31	77	0.95	------	5	------	sw.	----	----	----	2	11	17	7.4	T.	0.0
Harrisburg	374	94	104	29.80	30.22	+.11	44.6	+1.8	68	9	52	13	29	37	33	39	33	69	0.81	−1.4	9	4,323	w.	24	sw.	25	4	11	15	6.9	T.	0.0
Philadelphia	114	123	367	30.07	30.20	+.10	47.6	+1.9	69	17	54	17	28	41	28	42	36	68	2.36	−0.3	8	8,248	sw.	39	s.	30	8	9	13	5.9	T.	0.0
Reading	325	81	98	29.84	30.20	------	44.6	+2.1	66	9	52	14	29	37	29	40	35	72	2.11	−0.6	10	3,777	w.	21	nw.	6	7	8	15	6.7	T.	0.0
Scranton	805	111	119	29.29	30.18	+.09	43.0	+2.5	66	15	50	10	28	35	26	38	34	73	2.09	−0.7	11	4,417	sw.	27	nw.	6	5	10	15	6.6	1.0	0.0
Atlantic City	52	37	172	30.13	30.19	+.09	47.5	+1.9	63	15	53	17	28	42	25	44	40	78	2.74	−0.1	9	11,090	w.	72	ne.	4	12	6	12	5.4	T.	0.0
Cape May	17	13	49	----	------	------	48.3	+0.9	66	15	55	16	29	42	25	44	40	78	2.15	−1.1	8	------	nw.	----	----	----	9	11	10	----	T.	0.0
Sandy Hook	22	10	55	30.14	30.16	------	45.0	------	63	9	50	17	28	40	23	42	38	77	4.10	+0.8	11	10,172	sw.	58	ne.	4	8	10	12	5.8	T.	0.0
Trenton	190	159	183	29.96	30.18	------	44.8	+0.4	67	13	53	14	28	37	32	40	35	74	2.19	−0.5	11	6,720	ne.	35	ne.	4	9	9	12	6.0	T.	0.0
Baltimore	123	100	215	30.06	30.19	+.08	47.5	+1.2	73	9	54	17	28	41	36	42	36	70	1.13	−1.4	11	6,234	sw.	35	w.	27	11	4	15	5.9	T.	0.0
Washington	112	62	85	30.08	30.20	+.08	46.7	+1.5	71	10	54	14	29	39	37	41	35	69	0.79	−1.6	12	3,798	nw.	28	nw.	27	10	3	17	6.5	T.	0.0
Cape Henry	18	8	54	30.17	30.19	------	50.1	−2.0	74	22	56	24	27	44	25	47	42	78	0.87	−1.5	13	8,395	ne.	54	ne.	4	10	6	14	6.1	0.0	0.0
Lynchburg	681	153	188	29.46	30.22	+.09	46.0	−1.2	74	18	54	14	29	38	41	40	36	73	2.44	+0.1	9	3,638	w.	30	ne.	4	11	5	14	5.8	T.	0.0
Norfolk	91	170	205	30.10	30.21	+.10	51.0	−0.4	74	17	58	22	28	44	29	46	41	75	1.26	−0.9	11	8,131	ne.	49	ne.	4	10	5	15	5.9	0.0	0.0
Richmond	144	11	52	30.06	30.22	+.10	48.1	−0.2	71	18	57	16	29	39	40	42	38	75	1.63	−0.6	6	4,856	sw.	30	ne.	4	10	5	15	5.9	T.	0.0
Wytheville	2,304	49	55	27.77	30.22	+.09	41.0	−2.0	71	18	50	6	27	32	40	36	32	76	2.16	0.0	11	3,755	w.	24	sw.	25	9	5	16	6.4	2.1	0.0
South Atlantic States							**52.6**	**−1.6**										**77**	**3.35**	**+1.0**									**6.1**		
Asheville	2,253	70	84	27.81	30.23	+.09	44.1	−1.0	73	18	53	11	27	36	37	39	34	76	2.84	+0.6	10	5,329	se.	32	se.	16	10	5	15	5.9	1.2	0.0
Charlotte	779	55	62	29.36	30.22	+.09	48.8	−1.8	75	18	56	23	27	41	30	44	38	74	5.17	+2.6	9	3,231	ne.	23	w.	26	8	7	15	6.2	T.	0.0
Greensboro	886	5	56	29.24	30.22	------	45.2	------	73	18	54	13	28	36	45	40	37	83	3.06	------	10	4,836	ne.	36	n.	4	12	3	15	6.3	T.	0.0
Hatteras	11	5	50	30.16	30.17	+.06	54.8	−1.5	74	16	60	31	28	50	19	51	48	82	3.48	−0.1	12	9,099	n.	37	se.	4	10	4	16	6.1	T.	0.0
Raleigh	376	103	146	29.80	30.21	+.08	49.4	−1.6	74	18	58	19	29	41	32	44	38	71	1.95	−0.3	9	5,101	ne.	30	n.	4	9	5	16	6.3	T.	0.0
Wilmington	78	81	91	30.13	30.22	+.10	53.5	−2.5	78	17	62	26	27	45	32	48	43	74	1.92	0.0	8	4,145	n.	24	w.	26	10	6	14	5.7	0.0	0.0
Charleston	48	11	92	30.15	30.20	+.08	56.0	−2.1	78	16	62	30	27	50	22	51	47	78	1.23	−0.9	10	7,014	ne.	29	s.	30	8	8	14	6.2	0.0	0.0
Columbia, S. C.	351	41	57	29.83	30.22	+.10	52.0	−2.0	74	18	60	26	27	44	35	46	42	76	4.13	+2.2	9	4,380	ne.	26	w.	26	11	4	15	6.1	0.0	0.0
Due West	711	10	55	29.46	30.25	------	49.4	------	78	18	57	23	28	42	32	----	----	----	5.53	------	10	5,686	ne.	34	w.	26	10	5	15	6.1	0.0	0.0
Greenville, S. C.	1,039	139	146	29.09	30.21	------	49.0	−0.6	76	18	56	21	27	42	26	43	38	72	5.82	+2.6	9	5,722	ne.	34	w.	25	11	5	14	5.7	0.0	0.0
Augusta	182	62	77	30.00	30.19	+.06	53.4	−1.1	78	18	61	26	28	46	30	47	42	74	4.70	+2.3	11	3,425	ne.	23	w.	26	10	4	16	6.1	0.0	0.0
Savannah	65	150	194	30.11	30.18	+.06	56.5	−2.0	79	15	64	30	27	49	23	51	47	79	2.88	+0.8	11	7,516	ne.	36	s.	17	6	8	16	6.5	0.0	0.0
Jacksonville	43	209	245	30.12	30.17	+.07	60.6	−1.6	82	18	68	33	27	54	22	55	52	83	2.69	+0.7	11	7,765	n.	37	w.	25	9	5	16	6.5	0.0	0.0
Florida Peninsula							**69.8**	**−1.2**										**75**	**1.29**	**−1.0**									**5.8**		
Key West	22	10	64	30.06	30.08	+.06	72.8	−1.5	84	18	77	58	26	68	15	66	63	76	0.42	−1.8	7	7,368	ne.	36	nw.	25	8	12	10	5.7	0.0	0.0
Miami	25	124	168	30.08	30.11	+.04	70.6	−1.2	82	19	76	48	28	65	22	64	60	72	3.18	+0.3	9	8,290	ne.	30	ne.	29	4	13	13	6.3	0.0	0.0
Tampa	35	79	197	30.11	30.15	+.07	66.0	−0.9	85	18	74	39	27	58	26	59	56	78	0.26	−1.5	4	8,290	ne.	33	se.	29	5	11	14	6.1	0.0	0.0
Titusville	44	5	----	30.10	30.15	------	65.5	------	90	18	74	36	28	57	29	----	----	----	1.99	------	6	------	nw.	----	----	----	9	15	6	5.1	0.0	0.0
East Gulf States							**55.8**	**−0.3**										**76**	**7.68**	**+4.4**									**5.6**		
Atlanta	1,173	190	216	28.94	30.20	+.07	49.6	−2.5	76	18	56	23	27	43	26	44	38	70	5.94	+2.4	11	7,382	e.	33	w.	24	10	4	16	6.4	0.0	0.0
Macon	370	78	87	29.80	30.20	+.07	53.8	−0.4	79	18	62	26	28	46	30	48	42	73	6.60	+4.1	11	4,106	ne.	25	nw.	24	9	3	18	3.2	T.	0.0
Thomasville	273	49	103	29.88	30.18	+.06	58.1	−0.4	77	15	66	30	27	50	28	52	48	77	6.74	+4.1	11	5,302	ne.	21	se.	17	9	4	17	6.5	0.0	0.0
Apalachicola	36	11	51	30.12	30.16	------	60.4	------	75	15	66	36	1	54	23	56	53	80	8.67	+5.6	8	6,644	e.	25	e.	17	10	5	15	5.9	0.0	0.0
Pensacola	56	149	185	30.10	30.16	+.05	59.1	−1.1	76	18	65	34	1	53	24	55	51	79	14.82	+11.1	12	9,157	e.	35	e.	11	9	4	17	6.2	0.0	0.0
Anniston	741	9	57	29.40	30.21	+.09	51.7	−0.2	81	18	61	20	27	43	32	----	----	----	6.62	+3.4	13	3,750	se.	21	nw.	26	11	8	11	5.2	0.4	0.0
Birmingham	700	11	48	29.41	30.19	+.07	53.6	−0.3	82	18	62	24	27	45	27	47	42	72	7.38	+4.1	13	5,042	e.	39	se.	16	13	6	11	5.3	T.	0.0
Mobile	57	125	161	30.09	30.15	+.04	58.8	+0.2	80	18	66	34	27	52	30	54	51	82	7.57	+3.9	11	6,367	n.	28	nw.	24	9	6	15	6.2	0.0	0.0
Montgomery	223	100	112	29.94	30.19	+.07	55.5	−0.3	83	18	63	29	27	48	25	50	45	74	4.91	+1.7	13	4,587	e.	24	s.	16	10	6	14	5.8	0.0	0.0
Corinth	469	6	----	------	51.1	------	84	18	63	23	28	39	39	----	----	----	5.72	------	12	------	se.	----	----	----	4	16	10	----	0.0	0.0	0.0
Meridian	375	87	95	29.76	30.16	+.04	55.4	+1.2	83	18	64	26	27	46	34	50	46	80	9.15	+5.8	12	3,827	se.	22	se.	29	12	5	13	5.4	0.0	0.0
Vicksburg	247	65	73	29.89	30.17	+.05	56.2	−0.4	83	19	65	29	27	48	34	50	45	73	5.13	+1.4	13	4,429	se.	27	se.	29	11	8	11	5.2	0.0	0.0
New Orleans	53	76	84	30.08	30.14	+.04	62.5	+0.9	85	17	69	41	1	56	20	57	54	81	8.57	+5.4	14	4,469	ne.	20	nw.	24	13	5	12	5.3	0.0	0.0
West Gulf States							**57.4**	**−0.4**										**73**	**3.00**	**+0.1**									**5.6**		
Shreveport	249	77	93	29.88	30.16	+.05	55.6	−0.4	81	19	65	32	25	46	32	51	48	81	4.29	+0.6	5	3,987	se.	24	w.	19	15	6	9	4.4	0.0	0.0
Bentonville	1,303	11	44	28.72	30.11	.00	47.3	+0.6	78	18	59	24	26	36	37	----	----	----	4.26	------	7	3,536	se.	20	s.	23	2	5	----	T.	T.	0.0
Fort Smith	457	79	94	29.63	30.12	+.01	51.2	+0.2	84	18	62	25	27	41	35	44	38	67	2.78	−0.1	7	5,585	e.	30	nw.	24	17	6	7	4.2	T.	0.0
Little Rock	357	136	153	29.75	30.14	+.02	51.6	−0.5	82	18	60	27	27	43	33	45	38	66	2.38	−1.8	9	5,714	sw.	32	nw.	24	13	8	9	4.9	T.	0.0
Austin	605	136	148	29.49	30.12	------	58.6	+0.1	84	17	68	30	27	49	35	51	46	69	1.74	−0.6	11	4,554	n.	33	nw.	19	8	6	16	6.2	0.0	0.0
Brownsville	57	83	100	30.03	30.09	------	65.7	−1.5	83	17	72	45	25	60	21	61	58	82	5.95	+4.0	11	6,456	nw.	36	se.	19	6	10	14	7.0	0.0	0.0
Corpus Christi	20	11	78	30.09	30.11	+.04	64.0	−0.3	83	15	70	40	25	58	26	59	55	78	1.63	−0.4	10	7,169	ne.	31	s.	29	6	7	17	7.4	0.0	0.0
Dallas	512	220	227	29.58	30.13	------	55.9	------	79	15	65	36	26	47	29	----	----	----	2.22	−0.3	6	8,066	se.	42	sw.	15	15	7	8	4.2	0.0	0.0
Fort Worth	670	106	114	29.40	30.12	+.02	56.6	+1.1	80	15	67	34	25	47	34	49	43	66	1.71	−0.9	5	5,116	sw.	29	se.	19	13	6	11	4.7	0.0	0.0
Galveston	54	106	114	30.10	30.16	+.07	60.8	−2.5	78	17	66	43	25	56	22	57	53	79	4.45	+1.1	14	6,863	n.	32	s.	15	9	6	15	6.1	0.0	0.0
Groesbeck	461	11	56	29.64	30.14	------	56.6	------	81	15	66	29	27	47	33	----	----	----	3.86	+0.9	6	6,135	se.	30	sw.	25	11	7	12	5.5	0.0	0.0
Houston	138	292	314	29.99	30.15	------	59.8	−1.2	83	17	67	40	27	52	30	----	----	----	2.23	−1.6	14	8,262	ne.	40	nw.	15	10	4	16	5.8	0.0	0.0
Palestine	510	64	72	29.62	30.15	+.04	56.9	−0.3	81	15	66	34	25	48	29	49	44	70	3.23	−0.2	7	4,674	ne.	31	nw.	19	16	2	12	4.8	0.0	0.0
Port Arthur	34	58	66	30.11	30.15	------	59.9	------	83	17	67	37	25	53	23	55	52	80	3.88	+0.8	14	5,026	e.	26	nw.	24	10	6	14	6.0	0.0	0.0
San Antonio	693	242	301	29.39	30.11	+.03	59.7	−0.6	82	17	67	38	25	52	26	52	47	68	2.69	+0.8	12	6,975	ne.	34	nw.	19	7	8	15	6.7	0.0	0.0
Taylor	571	38	51	29.56	30.16	+.08	57.9	+0.2	82	17	68	29	27	48	37	----	----	----	1.96	−0.4	8	4,504	n.	24	nw.	19	12	7	11	5.5	0.0	0.0

TABLE 1.—*Climatological data for Weather Bureau stations, November, 1930*—Continued

District and station	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. + mean min. ÷ 2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest daily range	Mean wet thermometer	Mean temperature of the dew-point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with .01, or more	Wind: Total movement	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
Ohio Valley and Tennessee	*Ft.*	*Ft.*	*Ft.*	*In.*	*In.*	*In.*	*°F.*	*°F.*	*°F.*		*°F.*	*°F.*		*°F.*	*°F.*	*°F.*	*°F.*	*%*	*In.*	*In.*		*Miles*								*0–10*	*In.*	*In.*
							45.9	+0.7										73	2.03	−1.1										5.7		
Chattanooga	762	190	215	29.38	30.21	+0.07	49.6	−0.8	76	17	57	20	27	42	27	44	38	70	5.17	+1.8	14	5,144	se.	29	w.	24	10	9	11	5.8	0.1	0.0
Knoxville	995	102	111	29.13	30.20	+.07	48.4	+0.5	75	19	57	17	27	40	32	43	38	73	2.90	−0.2	12	3,635	ne.	31	s.	30	8	8	14	6.0	T.	0.0
Memphis	399	76	97	29.71	30.15	+.03	52.0	+0.3	82	18	59	26	28	45	25	46	41	71	2.42	−1.8	10	5,389	e.	31	sw.	25	11	9	10	5.4	T.	0.0
Nashville	546	168	191	29.60	30.20	+.08	49.0	0.0	78	18	58	18	27	40	31	44	39	73	3.19	−0.3	13	6,038	se.	40	nw.	26	10	6	14	5.6	T.	0.0
Lexington	989	193	230	29.11	30.21	+.09	45.6	+0.8	77	19	54	3	27	37	32				1.59	−1.8	11	8,510	s.	36	sw.	30	11	8	11	5.1	0.9	0.0
Louisville	525	188	234	29.59	30.18	+.06	46.8	+0.1	78	19	55	8	27	39	33	41	35	68	2.11	−1.5	13	6,688	se.	31	nw.	26	12	5	13	5.0	1.7	0.0
Evansville	431	76	116	29.68	30.16	+.04	47.6	+1.0	81	19	55	13	27	40	26	42	37	71	1.00	−2.7	16	6,175	s.	33	sw.	16	13	3	14	5.2	0.7	0.0
Indianapolis	822	194	230	29.23	30.14	+.04	44.0	+1.7	76	19	52	1	27	36	30	39	34	72	2.06	−1.3	12	7,471	s.	39	sw.	16	12	4	14	5.6	3.2	0.0
Royal Center	736	11	55	29.31	30.13	------	40.7	------	76	19	50	−3	28	32	30	----	----	----	2.73	+0.1	9	6,823	sw.	30	w.	24	9	5	16	6.0	1.7	T.
Terre Haute	575	96	129	29.50	30.14	------	44.6	------	77	19	53	4	28	36	30	40	35	74	1.80	−1.5	12	6,365	s.	32	w.	25	14	1	15	5.3	1.5	0.0
Cincinnati	627	11	51	29.48	30.17	+.05	45.0	+2.5	76	19	54	3	27	36	37	39	34	74	1.28	−1.6	11	4,726	sw.	24	sw.	26	12	4	14	5.5	1.9	0.0
Columbus	822	216	230	29.27	30.16	+.05	43.6	+1.7	72	19	52	3	27	35	32	38	33	74	1.31	−1.5	12	7,394	s.	37	w.	26	11	7	12	5.6	1.6	0.0
Dayton	899	137	173	29.18	30.16	------	43.7	+1.7	75	19	52	0	27	36	31	39	34	75	1.37	−1.5	8	5,756	sw.	28	nw.	26	11	7	12	5.6	0.7	0.0
Elkins	1,947	59	67	28.12	30.26	+.14	38.7	−1.6	70	21	52	−8	29	26	50	33	29	81	1.46	−1.3	14	2,995	w.	22	nw.	5	8	5	17	6.5	9.1	T.
Parkersburg	637	77	82	29.53	30.20	+.08	44.8	+1.0	74	19	55	8	27	35	38	38	33	73	1.11	−1.5	8	3,529	se.	24	sw.	26	8	7	15	6.4	1.8	0.0
Pittsburgh	842	353	410	29.25	30.18	+.08	43.9	+0.7	70	21	52	7	27	36	31	38	32	70	1.02	−1.3	11	6,209	sw.	34	nw.	30	10	5	15	6.1	2.6	0.0
Lower Lake Region							42.7	+3.4										73	1.60	−1.2									6.7		
Buffalo	767	247	280	29.25	30.10	+.05	42.7	+3.3	67	17	49	13	28	37	26	39	35	78	1.16	−1.9	8	11,964	sw.	58	w.	22	5	12	13	6.3	3.7	0.2
Canton	448	10	61	29.61	30.10	------	38.8	+4.9	64	21	47	1	29	31	32	----	----	----	1.55	−1.6	12	6,348	sw.	31	sw.	30	6	9	15	7.0	1.2	0.0
Ithaca	836	5	100	29.21	30.14	------	43.2	+4.6	67	14	50	10	29	36	29	38	32	70	0.59	−1.8	10	6,902	se.	28	nw.	6	4	11	15	7.2	0.7	T.
Oswego	335	71	85	29.74	30.12	+.07	42.1	+3.2	62	16	48	10	29	36	32	38	32	71	2.28	−1.1	10	7,334	s.	31	nw.	6	1	7	22	8.0	15.7	3.5
Rochester	523	86	102	29.54	30.13	+.08	43.4	+4.7	71	21	50	9	29	37	28	38	33	69	1.17	−1.4	9	5,337	sw.	25	w.	25	2	8	20	7.7	6.2	T.
Syracuse	596	65	79	29.47	30.13	+.07	44.2	+5.5	69	21	51	14	29	38	27	----	----	----	1.20	−1.6	9	4,610	s.	23	s.	30	4	9	17	7.4	4.4	0.2
Erie	714	130	166	29.33	30.12	+.06	44.0	+2.6	69	17	51	10	27	37	32	39	34	74	2.07	−1.2	10	10,598	s.	42	s.	30	5	10	15	6.5	11.2	T.
Cleveland	762	267	337	29.28	30.12	+.05	44.8	+3.9	71	17	52	8	27	38	37	39	33	67	2.27	−0.4	10	10,198	s.	46	w.	5	10	2	18	6.4	10.5	1.0
Sandusky	629	5	67	29.44	30.14	+.06	42.7	+1.6	72	20	51	5	27	34	35	----	----	----	1.45	−0.9	9	6,182	sw.	28	w.	26	8	11	11	5.9	1.8	T.
Toledo	628	208	243	29.43	30.13	+.06	42.8	+2.4	70	16	50	7	28	35	32	37	32	72	1.65	−0.8	6	8,775	sw.	34	w.	22	11	8	11	5.5	0.5	0.0
Fort Wayne	856	100	119	29.18	30.13	------	42.0	+1.4	75	19	50	1	28	34	30	37	33	76	2.14	−0.7	9	6,336	sw.	32	s.	16	9	7	14	6.3	3.2	0.0
Detroit	730	218	258	29.31	30.12	+.06	42.0	+2.7	67	20	49	9	28	35	24	38	36	83	1.72	−0.7	9	7,009	sw.	34	sw.	21	10	7	13	5.9	3.1	T.
Upper Lake Region							38.7	+3.3										79	1.49	−0.9									6.6		
Alpena	609	13	92	29.37	30.05	+.04	37.4	+3.0	61	12	44	6	28	31	22	35	31	82	0.88	−1.7	12	7,683	sw.	33	se.	16	5	5	20	7.1	4.2	2.0
Escanaba	612	54	60	29.33	30.02	−.01	36.9	+3.8	57	8	43	3	28	31	25	33	29	78	0.42	−1.7	5	7,380	sw.	30	nw.	24	10	8	12	5.9	0.6	T.
Grand Haven	632	54	89	29.35	30.05	+.01	41.6	+3.1	73	19	49	10	28	34	29	38	35	81	2.47	−0.2	11	8,768	se.	31	w.	27	5	5	20	7.6	11.4	2.0
Grand Rapids	707	70	244	29.30	30.09	+.04	42.2	+3.8	74	19	50	9	28	34	29	37	33	74	1.51	−1.3	9	8,478	sw.	38	sw.	21	5	5	20	7.5	3.7	T.
Houghton	668	64	99	29.23	29.97	−.05	36.1	+4.1	67	11	42	4	30	30	27	----	----	----	1.57	−1.4	11	7,010	e.	30	w.	22	2	8	20	8.0	10.4	6.0
Lansing	878	6	49	29.12	30.09	------	39.6	+2.1	67	19	48	5	28	31	29	36	34	87	0.96	−1.5	10	4,026	sw.	22	nw.	5	5	11	14	6.6	4.5	T.
Ludington	637	60	66	29.33	30.04	------	41.2	+3.8	69	19	47	12	28	35	26	38	34	77	1.59	−1.1	13	8,974	se.	38	sw.	21	8	3	19	6.8	7.3	2.2
Marquette	734	77	111	29.17	29.99	−.03	37.6	+4.3	64	19	44	2	28	31	28	33	29	77	1.98	−0.9	12	8,560	s.	34	s.	16	2	5	23	8.1	16.0	9.6
Port Huron	638	70	120	29.38	30.09	+.04	40.6	+3.1	65	9	48	7	28	33	25	36	32	78	0.94	−1.4	6	7,827	s.	29	nw.	5	7	13	10	5.9	0.5	0.0
Sault Sainte Marie	614	11	52	29.32	30.03	+.02	36.2	+4.2	57	17	42	−3	28	30	24	33	31	83	2.29	−0.4	11	6,268	se.	28	se.	16	4	7	19	7.3	4.4	3.2
Chicago	673	7	131	29.35	30.09	+.02	42.4	+2.3	75	19	50	1	28	35	25	37	32	72	1.75	−0.6	7	7,421	sw.	27	sw.	21	10	10	10	5.4	1.7	0.0
Green Bay	617	109	141	29.34	30.01	−.03	38.8	+4.8	63	19	47	0	28	31	26	34	29	74	0.64	−1.5	4	8,547	s.	36	s.	16	8	10	12	6.2	0.5	T.
Milwaukee	681	125	221	29.30	30.05	.00	40.1	+2.8	66	9	48	0	28	32	23	36	32	78	0.89	−0.9	7	9,518	sw.	39	sw.	16	12	7	11	5.1	4.2	1.3
Duluth	1,133	5	47	28.73	29.98	−.06	31.6	+1.6	62	11	40	−11	28	24	33	28	25	80	2.96	+1.5	7	9,390	sw.	40	nw.	26	11	6	13	5.4	0.5	T.
North Dakota							29.4	+2.6										78	1.27	+0.6									6.0		
Moorhead	940	50	58	28.96	30.00	−.07	30.4	+3.3	62	3	40	−6	28	21	35	26	22	79	2.56	+1.7	10	6,652	n.	38	n.	25	6	10	14	6.5	6.7	1.2
Bismarck	1,674	8	57	28.21	30.05	−.02	31.1	+2.6	68	3	42	−4	26	20	42	26	21	73	0.98	+0.4	6	6,331	nw.	42	nw.	25	14	5	11	4.8	13.1	6.5
Devils Lake	1,478	11	44	28.40	30.03	−.03	27.8	+3.3	61	3	38	−11	30	18	38	24	21	85	0.81	+0.1	11	7,192	nw.	42	nw.	25	4	11	15	7.1	9.6	4.0
Ellendale	1,457	10	56	28.41	30.01	------	31.0	------	68	8	42	−3	27	20	41	----	----	----	1.39	+0.6	10	10,784	nw.	61	nw.	25	4	9	17	6.8	5.6	1.7
Grand Forks	833	12	67	------	------	------	28.7	------	61	11	38	−8	30	19	37	25	----	----	3.09	------	9	------	nw.	49	n.	25	6	15	9	----	8.2	4.4
Williston	1,878	41	48	28.04	30.08	+.02	28.5	+1.3	66	3	39	2	20	18	37	24	20	76	0.61	0.0	5	4,849	w.	36	nw.	23	16	5	9	4.6	5.2	0.8
Upper Mississippi Valley							42.1	+3.7										73	1.97	0.0									4.6		
Minneapolis	918	102	208	28.98	29.98	------	37.0	+4.6	68	13	46	−4	28	28	29	----	----	----	2.41	+1.1	8	8,087	s.	29	nw.	4	9	6	15	5.9	4.7	2.9
St. Paul	837	236	261	29.05	29.97	−.09	36.4	+3.9	67	13	46	−7	28	27	30	----	----	----	1.72	+0.4	10	8,689	nw.	42	sw.	20	11	7	12	5.4	7.1	5.5
La Crosse	714	11	48	29.22	30.01	−.06	39.2	+4.0	73	19	50	−8	28	29	32	34	30	76	2.00	+0.4	10	4,194	s.	20	sw.	16	9	11	10	5.4	3.2	2.2
Madison	974	70	78	28.97	30.05	−.01	39.0	+3.8	70	19	48	−4	28	30	27	35	31	77	0.65	−1.1	7	7,008	s.	28	sw.	21	13	7	10	4.8	1.3	0.2
Wausau	1,247	4	62	------	30.02	------	36.4	------	63	11	46	−6	28	27	26	----	----	----	1.21	−0.6	6	4,885	s.	21	w.	21	7	11	12	----	0.6	T.
Charles city	1,015	10	51	28.94	30 04	−.04	38.4	+5.4	69	19	49	−6	28	28	31	33	29	76	1.76	+0.2	8	5,370	se.	25	s.	20	16	5	9	4.2	2.7	0.8
Davenport	606	71	79	29.40	30.08	.00	42.8	+3.8	77	19	52	0	28	34	28	37	31	71	1.72	−0.1	7	7,673	se.	36	sw.	20	14	9	7	4.1	2.7	T.
Des Moines	861	5	99	29.12	30.05	−.03	43.4	+5.0	72	19	54	9	26	33	33	37	31	67	1.05	−0.4	8	7,661	s.	40	nw.	25	12	7	11	5.0	0.3	0.0
Dubuque	700	81	96	29.29	30.06	−.01	40.6	+3.6	72	19	50	−2	28	31	28	36	31	75	0.79	−0.9	8	4,737	s.	23	nw.	24	17	3	10	4.3	3.3	0.7
Keokuk	614	64	78	29.42	30.11	+.02	44.2	+3.1	75	19	54	9	28	34	33	37	30	66	3.63	+1.7	6	5,723	sw.	31	nw.	25	18	5	7	3.5	0.1	0.0
Cairo	358	87	93	29.76	31.15	+.03	48.6	+1.3	79	19	56	21	28	41	28	44	39	75	1.83	−1.8	9	5,567	se.	27	se.	15	10	6	14	5.8	T	0.0
Peoria	609	11	45	29.44	30.11	+.02	42.4	+4.9	78	19	52	−1	28	33	32	37	33	76	3.07	+0.7	8	4,846	s.	23	sw.	16	15	6	9	4.2	3.8	T.
Springfield, Ill	636	5	191	29.41	30.10	.00	44.4	+2.2	77	19	54	7	28	35	30	39	34	74	2.51	0.0	8	9,214	s.	32	nw.	26	15	10	7	4.5	0.4	0.0
Hannibal	534	74	109	29.53	30.12	+.03	45.3	+3.2	75	19	56	14	28	35	34	----	----	----	3.36	+1.3	8	6,465	sw.	32	sw.	16	17	6	7	3.6	0.7	0.0
St. Louis	568	265	303	29.50	30.11	+.01	47.6	+2.5	74	19	56	15	28	39	29	41	36	70	1.77	−1.1	8	8,948	s.	40	sw.	16	13	11	6	3.8	0.2	0.0
Missouri Valley							42.2	+3.3										65	2.38	+1.0									3.8		
Columbia, Mo	784	6	84	29.26	30.11	+.02	46.0	+2.7	78	18	57	16	28	35	35	----	----	----	2.25	0.0	7	6,014	se.	38	nw.	25	15	11	4	3.5	0.3	0.0
Kansas City	963	161	181	29.03	30.09	.00	47.7	+3.7	75	18	57	19	26	38	27	40	32	62	2.70	+0.9	6	7,318	s.	48	nw.	25	18	10	2	2.6	T.	0.0
St. Joseph	967	11	49	29.01	30.07	------	46.0	------	73	15	56	15	26	36	30	38	31	63	3.87	+2.2	5	6,591	se.	47	nw.	25	22	4	4	2.4	T.	0.0
Springfield, Mo	1,324	98	104	28.70	30.12	+.02	46.2	+0.5	78	18	55	20	26	37	28	40	33	67	2.11	−0.7	6	8,057	se.	40	se.	19	21	5	4	2.4	T.	0.0
Iola	984	11	50	29.03	30.10	+.01	46.2	+2.1	74	18	58	22	26	34	37	----	----	----	2.85	+1.0	6	4,759	s.	26	sw.	20	16	7	7	3.8	T.	0.0
Topeka	987	92	107	------	------	------	46.2	+3.4	70	19	57	19	26	36	32	----	----	----	2.95	+1.4	5	7,454	s.	44	nw.	25	19	6	5	2.7	T.	0.0
Lincoln	1,189	11	81	28.76	30.05	−.03	44.4	+5.3	71	13	55	15	26	34	33	37	30	65	3.40	+2.3	4	7,545	s.	51	nw.	25	13	10	7	4.2	1.0	0.0
Omaha	1,105	115	122	28.84	30.05	−.03	44.0	+5.5	70	13	54	11	26	34	32	36	29	62	2.17	+1.1	4	5,684	s.	41	nw.	25	18	5	7	3.2	1.1	0.0
Valentine	2,598	47	54	27.30	30.08	.00	35.7	+1.1	73	8	48	11	16	24	43	29	23	68	1.26	+0.7	7	6,499	w.	53	n.	20	14	5	11	5.0	11.9	4.8
Sioux City	1,135	94	164	28.80	30.04	−.04	40.2	+5.0	69	13	50	9	26	30	33	34	29	69	2.99	+2.0	7	9,133	nw.	51	nw.	25	12	11	7	4.7	0.4	0.0
Huron	1,306	59	74	28.61	30.04	−.04	34.8	+3.3	68	8	46	4	26	24	38	29	23	70	1.52	+0.9	7	7,005	nw.	44	nw.	25	12	9	9	4.6	1.4	T.
Pierre	1,572	70	75	28.35	30.06	−.02	36.2	+2.6	73	8	47	9	26	25	41	30	22	62	1.01	+0.5	4	6,283	nw.	45	nw.	20	12	8	10	5.1	10.6	1.1
Yankton	1,233	49	57	28.67	30.02	−.06	39.3	+4.0	70	13	50	10	26	29	39	----	----	----	1.84	+1.0	6	5,845	nw.	37	nw.	25	12	10	8	4.7	1.2	T.

TABLE 1.—*Climatological data for Weather Bureau stations, November, 1930*—Continued

District and station	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. + mean min. ÷ 2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest daily range	Mean wet thermometer	Mean temperature of the dew-point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with .01, or more	Wind: Total movement	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	Ft.	Ft.	In.	In.	In.	°F.	°F.	°F.		°F.	°F.		°F.	°F.	°F.	°F.	%	In.	In.		Miles								0–10	In.	In.
Northern Slope							**33.5**	**+0.7**										**68**	**0.90**	**+0.2**										**5.3**		
Billings	3,140	5					34.6		71	8	49	−8	15	20	47				0.52		2		nw.									
Havre	2,505	11	44	27.41	30.12	+0.09	30.7	−0.5	71	3	42	−11	15	19	41	26	21	76	0.82	+0.2	4	6,317	sw.	28	sw.	11	9	9	12	6.0	6.6	0.5
Helena	4,124	89	113	25.87	30.17	+.07	34.0	+0.8	64	2	44	−1	15	24	33	28	22	63	0.48	−0.3	3	3,946	sw.	26	sw.	24	4	14	12	6.6	7.8	T.
Kalispell	2,973	48	56	27.07	30.22	+.15	29.6	−2.8	55	11	36	4	19	23	24	28	25	85	2.49	+1.1	10	1,843	nw.	15	w.	11	1	6	23	8.7	30.4	5.0
Miles City	2,371	48	55	27.53	30.15	+.08	34.4	+3.5	72	3	46	1	20	22	41	29	24	72	0.38	−0.2	4	3,411	s.	33	nw.	23	13	9	8	4.8	3.1	T.
Rapid City	3,259	50	58	26.63	30.13	+.05	39.5	+3.6	74	7	51	15	28	28	45	31	22	58	0.77	+0.3	4	5,965	w.	47	nw.	23	11	10	9	5.0	7.0	T.
Cheyenne	6,088	84	101	24.01	30.10	+.03	36.0	+1.2	67	3	47	13	21	25	37	27	17	51	0.83	+0.3	4	8,880	w.	54	w.	16	17	5	8	4.0	9.3	T.
Lander	5,372	60	68	24.69	30.18	+.08	33.4	+3.1	59	3	46	9	22	20	37	26	19	65	0.01	−0.6	1	2,260	sw.	40	sw.	16	19	4	7	3.6	0.2	0.0
Sheridan	3,790	10	47	26.14	30.14		35.6		71	3	50	8	20	21	48	28	22	67	0.19	−0.4	5	2,840	nw.	29	nw.	23	10	14	6	4.7	2.5	0.0
Yellowstone Park	6,241	11	48		30.30	+.19	26.4	−2.9	59	2	38	−4	19	15	35			69	1.11	−0.2	8	4,039	sw.	38	sw.	12	7	10	13		21.6	10.5
North Platte	2,821	11	51	27.08	30.07	−.01	37.2	+0.6	70	9	49	13	16	25	45	30	26	74	1.93	+1.5	3	4,457	w.	30	n.	25	12	10	8	4.5	7.5	0.4
Middle Slope							**45.0**	**+2.2**										**61**	**2.11**	**+0.9**										**3.0**		
Denver	5,292	106	113	24.74	30.08	+.02	40.4	+0.6	70	3	52	11	22	28	37	31	18	46	0.90	+0.4	3	4,808	s.	37	w.	16	16	11	3	3.3	13.6	0.0
Pueblo	4,685	89	86	25.28	30.04	−.01	40.5	+1.1	74	3	56	8	22	25	47	30	19	50	0.44	+0.1	3	4,353	nw.	43	nw.	19	20	8	2	2.8	4.4	0.0
Concordia	1,392	59	58	28.59	30.09	+.01	44.8	+3.4	71	18	56	20	28	34	34	37	32	68	3.14	+2.2	6	6,080	s.	43	nw.	25	17	9	4	3.3	0.2	0.0
Dodge City	2,509	11	51	27.45	30.10	+.03	45.8	+3.2	74	14	58	23	16	33	39	37	32	71	1.77	+1.0	3	6,606	s.	31	nw.	20	21	5	4	2.6	T.	0.0
Wichita	1,358	139	158	28.61	30.07	−.01	47.0	+2.2	71	18	57	25	26	37	30	40	34	66	3.05	+1.7	5	8,461	s.	38	s.	20	18	8	4	3.1	T.	0.0
Broken Arrow	765	11	56	29.28	30.12		49.0		80	18	60	26	26	38	36				3.39	+0.6	5	8,584	s.	54	s.	19	19	6	5	3.3	T.	0.0
Oklahoma City	1,214	10	47	28.81	30.11	+.03	51.2	+2.4	80	18	62	28	26	40	32	42	36	63	2.11	+0.2	4	6,178	s.	30	sw.	20	22	2	6	2.6	0.0	0.0
Southern Slope							**51.6**	**−0.1**										**66**	**1.07**	**0.0**										**4.5**		
Abilene	1,738	10	52	28.30	30.13	+.06	53.6	+0.1	79	18	64	32	21	44	35	45	38	65	1.33	0.0	4	5,745	s.	35	sw.	15	11	8	11	5.0	0.0	0.0
Amarillo	3,676	10	49	26.31	30.08	+.03	48.2	+2.7	76	3	60	26	24	36	33	38	31	63	0.33	−0.6	4	6,394	sw.	24	w.	19	21	4	5	2.7	1.2	0.0
Del Rio	944	64	71	29.10	30.10	+.05	57.6	−2.4	80	18	66	36	20	49	30	52	48	74	2.19	+1.0	12	3,938	nw.	38	nw.	19	7	9	14	6.3	0.0	0.0
Roswell	3,566	75	85	26.44	30.09	+.06	47.2	−0.9	72	4	60	23	25	35	45	39	32	63	0.43	−0.4	6	4,596	s.	36	w.	15	14	11	5	4.1	T.	0.0
Southern Plateau							**49.1**	**−0.2**										**53**	**0.48**	**0.0**										**3.1**		
El Paso	3,778	152	175	26.26	30.09	+.09	51.6	−1.1	73	1	61	28	21	42	35	41	32	53	0.74	+0.2	5	7,027	e.	43	w.	19	16	9	5	3.7	T.	0.0
Santa Fe	7,013	38	53	23.27	30.12	+.09	36.4	−2.5	65	3	47	11	23	26	33	28	21	61	1.12	+0.4	5	3,561	n.	23	s.	18	14	10	6	3.9	11.0	T.
Flagstaff	6,907	10	59	23.36	30.06	+.04	34.2	−0.4	64	1	49	−1	19	19	46	27		70	2.55		7	4,811	e.	32	sw.	17	16	8	6		1.0	T.
Phoenix	1,108	10	107	28.83	29.99	+.01	60.2	+0.5	89	2	74	31	21	47	39	48	37	47	0.51	−0.2	5	3,393	e.	29	w.	17	17	8	5	3.4	0.0	0.0
Yuma	141	9	54	29.85	30.00	+.02	63.6	+1.2	90	3	77	35	20	50	38	49	33	35	T.	−0.3	0	3,963	n.	24	nw.	14	26	4	0	1.3	0.0	0.0
Independence	3,957	6	27	26.06	30.13	+.08	48.6	+1.4	79	3	64	17	15	33	43	34			0.02	−0.3	2		nw.				21	3	6		0.0	0.0
Middle Plateau							**35.9**	**−3.3**										**61**	**1.12**	**+0.3**										**3.0**		
Reno	4,532	74	81	25.58	30.18	+.07	40.7	−0.3	73	2	56	6	14	26	44	33	25	58	1.07	+0.4	3	2,808	w.	28	w.	16	22	5	3	2.5	3.3	0.0
Tonopah	6,090	12	20				39.8		68	1	48	10	19	31	22	32	23	55	0.20		2		nw.									
Winnemucca	4,344	18	56	25.75	30.24	+.10	35.4	−3.0	71	2	52	1	14	19	51	28	20	64	1.28	+0.6	4	4,441	ne.	36	sw.	16	21	5	4	2.6	10.4	T.
Modena	5,473	10	43	24.70	30.18	+.10	31.2	−5.2	68	7	46	−8	15	17	45	25	18	67	1.17	+0.6	5	5,184	w.	48	sw.	13	17	7	6	3.4	9.7	0.2
Salt Lake City	4,360	163	203	25.76	30.24	+.12	34.6	−6.5	60	2	43	13	30	27	32	30	24	66	1.07	−0.3	6	3,780	s.	37	s.	16	16	7	7	3.5	14.3	2.2
Grand Junction	4,602	60	68	25.47	30.12	+.04	37.8	−1.5	68	1	50	15	23	26	39	29	19	56	1.02	+0.4	5	3,624	se.	25	s.	14	19	6	5	2.9	5.6	0.0
Northern Plateau							**36.3**	**−3.1**										**76**	**1.02**	**−0.5**										**6.6**		
Baker	3,471	48	53	26.60	30.27	+.11	32.9	−3.1	64	3	44	7	19	22	37	28	23	72	0.36	−0.7	5	3,812	se.	20	n.	12	9	10	11	5.9	5.8	0.2
Boise	2,739	79	87	27.36	30.29	+.12	37.1	−3.9	70	8	47	15	27	27	38	32	27	71	0.99	−0.3	6	2,360	se.	20	se.	15	7	17	6	5.3	4.8	0.0
Lewiston	757	40	48	29.41	30.24	+.12	40.3	−1.1	65	10	49	25	15	32	33				0.64	−1.0	7	1,190	e.	23	w.	12	4	8	18	7.4	0.2	0.0
Pocatello	4,477	60	68	25.62	30.29	+.15	30.2	−6.5	65	8	42	3	22	18	36	24	20	73	0.97	+0.1	5	4,183	se.	32	s.	16	12	11	7	4.8	10.0	1.5
Spokane	1,929	101	110	28.12	30.23	+.13	36.4	−2.1	57	10	42	18	19	31	25	34	32	83	1.53	−0.6	8	2,743	s.	19	sw.	16	2	6	22	8.0	5.4	T.
Walla Walla	991	57	65	29.12	30.22	+.09	41.0	−1.8	65	10	47	28	28	35	30	38	34	79	1.64	−0.4	8	2,049	s.	24	s.	15	5	4	21	7.9	0.9	0.0
North Pacific Coast Region							**44.9**	**−0.3**										**81**	**2.52**	**−3.0**										**7.6**		
North Head	211	11	56	29.88	30.11	+.06	49.6	+1.4	68	1	54	36	14	45	20	47	44	83	3.85	−4.6	14	8,449	se.	60	s.	8	6	5	19	7.3	0.0	0.0
Port Angeles	29	8	53		30.14		42.7		65	8	47	30	14	38	17				1.62	−2.3	10	3,121	s.	23	w.	16	1	6	23		0.2	0.0
Seattle	125	215	250	29.99	30.12	+.08	44.8	−0.8	65	7	50	29	27	40	26	43	40	85	1.75	−3.3	9	4,402	se.	31	s.	8	1	9	20	7.8	T.	0.0
Tacoma	194	172	201	29.92	30.14	+.10	43.5	−1.1	64	8	49	28	27	38	21				2.27	−4.0	12	4,090	s.	36	s.	8	0	3	27	9.0	1.5	0.0
Tatoosh Island	86	9	53	29.98	30.03	+.11	46.9	+1.0	59	1	50	36	17	44	13	45	44	91	3.99	−7.9	17	12,729	e.	50	s.	8	6	4	20	7.3	0.0	0.0
Yakima	1,076	58	67	29.04	30.22		38.2	−0.7	63	8	46	20	18	30	31	34	30	75	0.39	−0.5	5	1,845	se.	21	w.	12	6	8	16	7.1	5.5	0.0
Medford	1,329	29	58	28.72	30.16		43.3		74	7	56	22	29	31	48	39	34	76	2.17	−0.3	6		s.	25	w.	16	7	13	10	6.2	T.	0.0
Portland, Oreg.	153	68	106	29.99	30.15	+.05	46.0	−0.8	69	1	52	29	25	40	23	43	39	80	2.84	−3.3	11	3,481	se.	20	e.	23	2	8	20	7.9	0.0	0.0
Roseburg	510	75	99	29.60	30.16	+.04	45.0	−0.9	74	1	52	34	24	38	30	43	41	86	3.78	−0.9	10	1,859	s.	20	sw.	16	2	9	19	8.0	T.	0.0
Middle Pacific Coast Region							**54.6**	**+0.8**										**66**	**1.53**	**−1.2**										**4.0**		
Eureka	62	73	89	30.06	30.14	+.03	51.2	+0.1	74	22	58	34	18	44	30	48	46	84	3.20	−2.0	10	3,150	se.	26	sw.	16	10	6	14	5.8	0.0	0.0
Red Bluff	330	5	58	29.72	30.09	−.02	55.5	+1.7	83	11	69	33	14	42	38	45	34	49	1.05	−1.9	4	3,700	nw.	24	se.	15	19	7	4	3.4	0.0	0.0
Sacramento	69	106	117	30.00	30.07	−.02	54.8	+1.2	82	1	67	35	20	43	37	49	42	66	1.11	−0.8	6	3,741	nw.	29	se.	15	22	4	4	2.3	0.0	0.0
San Francisco	155	208	243	29.91	30.08	−.01	58.0	+1.7	79	11	65	45	18	51	25	51	44	67	1.56	−0.8	8	3,558	n.	25	s.	15	12	11	7	4.4	0.0	0.0
San Jose	141	12	110	29.94	30.09		53.6	−0.8	83	1	66	33	20	41	41				0.73	−0.7	6	3,283	nw.	27	se.	15	16	7	7	4.1	0.0	0.0
South Pacific Coast Region							**61.7**	**+3.4**										**55**	**1.21**	**+0.3**										**2.4**		
Fresno	327	89	98	29.73	30.09	+.03	55.9	+1.7	85	7	68	35	23	44	36	47	38	59	0.88	0.0	4	2,707	nw.	16	nw.	22	20	4	6	2.7	0.0	0.0
Los Angeles	338	159	191	29.66	30.03	+.01	66.2	+5.3	92	1	76	43	19	56	28	52	39	47	1.71	+0.5	7	3,663	ne.	30	ne.	22	23	3	4	2.0	0.0	0.0
San Diego	87	62	70	29.92	30.01	−.01	63.0	+3.3	92	1	72	42	19	54	32	53	45	58	1.04	+0.3	8	3,760	nw.	28	w.	18	21	5	4	2.4	0.0	0.0
West Indies																																
San Juan, P. R.	82	9	54	29.84	29.92		79.2	+0.8	91	5	84	70	17	74	16				5.35	−1.4	20	6,735	e.	36	ne.	16	2	22	6	5.8	0.0	0.0
Panama Canal																																
Balboa Heights	118	7	97		[1]29.82		80.8	+1.7	91	8	88	72	22	74	17				5.12	−5.0	20	4,646	nw.	25	nw.	26	0	15	15		0.0	0.0
Cristobal	36	7	97		[1]29.84		81.8	+2.5	89	1	86	74	29	77	13				16.94	−4.1	26	7,654	n.	30	w.	26	3	11	16		0.0	0.0
Alaska																																
Fairbanks	455	11	44		[2]29.85		−3.0		35	4	6	−37	29	−12	39			78	0.69		11	1,383	n.	23	ne.	2	7	4	19		9.2	10.4
Juneau	80	11	50	[2]29.70	[2]29.79		37.0		52	1	42	20	13	32	16	36	34	87	13.20		27	5,623	se.	32	e.	7	1	4	25	9.1	21.4	4.0
Hawaiian Islands																																
Honolulu	38	86	100	[2]29.92	[2]29.96		75.6	+1.1	84	12	80	63	27	71	16	70	68	80	3.98	+0.1	11	4,901	e.	28	e.	16	17	8	5	4.2	0.0	0.0

[1]. Observations taken bihourly.

[2] Pressure not reduced to mean of 24 hours.

TABLE 2.—*Data furnished by the Canadian Meteorological Service, November, 1930*

Stations	Altitude above mean sea level, Jan. 1, 1919	Pressure			Temperature of the air						Precipitation		
		Station reduced to mean of 24 hours	Sea level reduced to mean of 24 hours	Departure from normal	Mean max. + mean min.÷2	Departure from normal	Mean maximum	Mean minimum	Highest	Lowest	Total	Departure from normal	Total snowfall
	Feet	*Inches*	*Inches*	*Inches*	*° F.*	*°F.*	*° F.*	*°F.*	*°F.*	*° F.*	*Inches*	*Inches*	*Inches*
Cape Race, N. F	99												
Sydney, C. B. I	48	30.04	30.09	+0.14	40.2	+3.1	47.6	32.7	62	21	3.38	−2.06	T.
Halifax, N. S	88	30.02	30.13	+.12	39.7	+2.4	47.9	31.5	57	14	3.02	−2.64	0.6
Yarmouth, N. S	65	30.01	30.08	+.06	41.1	+1.2	48.6	33.7	57	18	2.77	−1.72	6.1
Charlottetown, P. E. I	38	29.99	30.03	+.07	38.8	+3.3	44.8	32.8	60	13	1.58	−2.39	8.1
Chatham, N. B	28	29.96	29.99	+.02	33.9	+2.9	43.6	24.3	54	6	1.20	−2.55	0.2
Father Point, Que	20												
Quebec, Que	296	29.76	30.10	+.08	34.0	+5.0	39.0	29.1	51	3	3.57	−0.19	8.5
Doucet, Que	1,236												
Montreal, Que	187	29.88	30.09	+.06	38.2	+6.4	43.8	32.6	57	7	2.67	−1.07	5.4
Ottawa, Ont	236	29.82	30.09	+.07	37.6	+5.9	44.7	30.5	59	2	2.03	−0.51	4.8
Kingston, Ont	285	29.79	30.11	+.07	40.9	+5.9	46.8	35.1	61	10	1.29	−1.95	0.5
Toronto, Ont	379	29.68	30.10	+.06	40.8	+5.2	46.7	34.9	61	13	0.68	−2.46	1.1
Cochrane, Ont	930												
White River, Ont	1,244	28.59	29.94	−.04	28.6	+8.1	36.2	21.0	59	−20	2.17	+0.32	9.0
London, Ont	808				38.8		46.1	31.5	64	5	5.74		26.5
Southampton, Ont	656	29.33	30.06	+.04	39.9	+4.9	46.7	33.1	66	9	3.24	−0.46	26.4
Parry Sound, Ont	688	29.35	30.06	+.05	38.2	+6.1	44.3	32.1	60	0	1.49	−2.88	3.6
Port Arthur, Ont	644	29.25	29.98	−.02	31.2	+7.2	37.2	25.3	51	−8	3.80	+2.47	1.6
Winnipeg, Man	760	29.14	30.00	−.04	25.5	+7.5	33.7	17.9	58	−14	1.55	+0.47	14.0
Minnedosa, Man	1,690	28.15	30.04	.00	23.8	+6.5	34.1	13.5	60	−16	0.29	−0.71	2.9
Le Pas, Man	860				19.0		26.6	11.4	43	−20	0.25		2.5
Qu'Appelle, Sask	2,115	27.70	30.01	+.01	24.1	+5.3	34.0	14.3	63	−15	0.64	−0.25	6.0
Moose Jaw, Sask	1,759				28.0		39.3	16.6	68	−7	0.53		5.0
Swift Current, Sask	2,392	27.41	30.00	−.02	29.9	+6.7	40.4	19.3	67	−10	0.33	−0.36	2.8
Medicine Hat, Alb	2,144	27.54	29.83	−.17	33.5	+6.1	42.9	24.1	70	0	0.51	−0.41	2.5
Calgary, Alb	3,428												
Banff, Alb	4,521	25.38	30.09	+.13	28.3	+2.5	36.0	20.5	54	−9	0.20	−2.07	1.3
Prince Albert, Sask	1,450	28.44	30.06	+.03	23.7	+8.3	32.0	15.5	53	−10	0.25	−0.58	2.5
Battleford, Sask	1,592	28.26	30.06	+.04	26.8	+10.5	35.8	17.8	60	−20	0.13	−0.45	1.3
Edmonton, Alb	2,150	27.63	29.96	−.01	28.4	+5.5	38.3	18.6	65	0	0.88	+0.30	8.8
Kamloops, B. C	1,262												
Victoria, B. C	230	29.86	30.12	+.13	44.0	+0.8	47.6	40.5	56	32	1.31	−5.66	0.0
Barkerville, B. C	4,180												
Estevan Point, B. C	20												
Prince Rupert, B. C	170												
Hamilton, Ber	151												
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Cape Race, N. F	99				47.5		53.0	41.9	64	32	9.48		0.0
Sydney, C. B. I	48	29.95	30.00	+0.04	50.6	+4.1	56.4	44.9	78	28	6.18	+1.49	0.0
Halifax, N. S	88	29.86	29.97	−.03	51.6	+4.4	58.5	44.6	88	30	7.65	+2.10	0.0
Yarmouth, N. S	65	29.86	29.93	−.09	51.8	+4.2	58.4	45.2	71	31	5.00	+0.88	T.
Charlottetown, P. E. I	38	29.91	29.95	−.01	50.3	+3.8	56.1	44.6	82	33	3.27	−1.63	0.0
Chatham, N. B	28	29.93	29.95	.00	46.6	+3.6	55.8	37.5	84	23	0.88	−2.98	T.
Medicine Hat, Alb	2,144	27.54	29.81	−.16	40.8	−4.0	51.3	30.2	71	6	0.87	+0.29	1.0
Calgary, Alb	3,428	26.39	30.01	+.06	36.5	−3.6	47.5	25.5	71	6	0.84	+0.36	7.6
Banff, Alb	4,521	25.37	30.01	+.06	34.2	−5.1	44.0	24.3	69	−7	1.08	+0.06	9.2
Edmonton, Alb	2,150	27.66	29.98	+.05	35.2	−5.9	45.1	25.3	75	−8	0.73	+0.03	6.4
Kamloops, B. C	1,262	28.76	30.03	+.12	44.1	−2.9	50.7	37.5	69	27	1.03	+0.42	0.8
Estevan Point, B. C	20				48.2		54.5	41.9	61	30	7.77		0.0
Prince Rupert, B. C	170				45.2		50.0	40.5	60	29	11.67		T.

Chart I. Departure (°F.) of the Mean Temperature from the Normal, November, 1930

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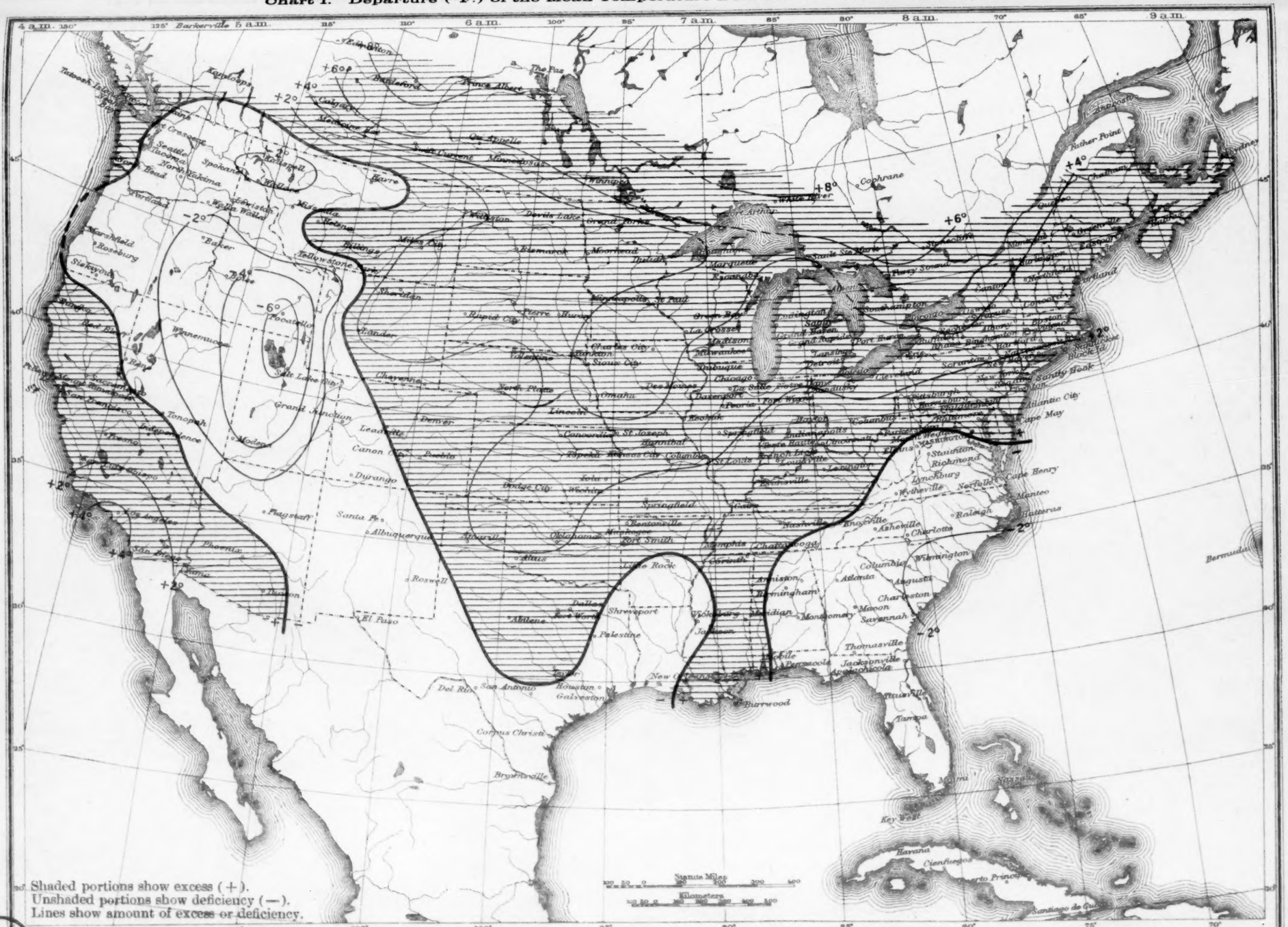
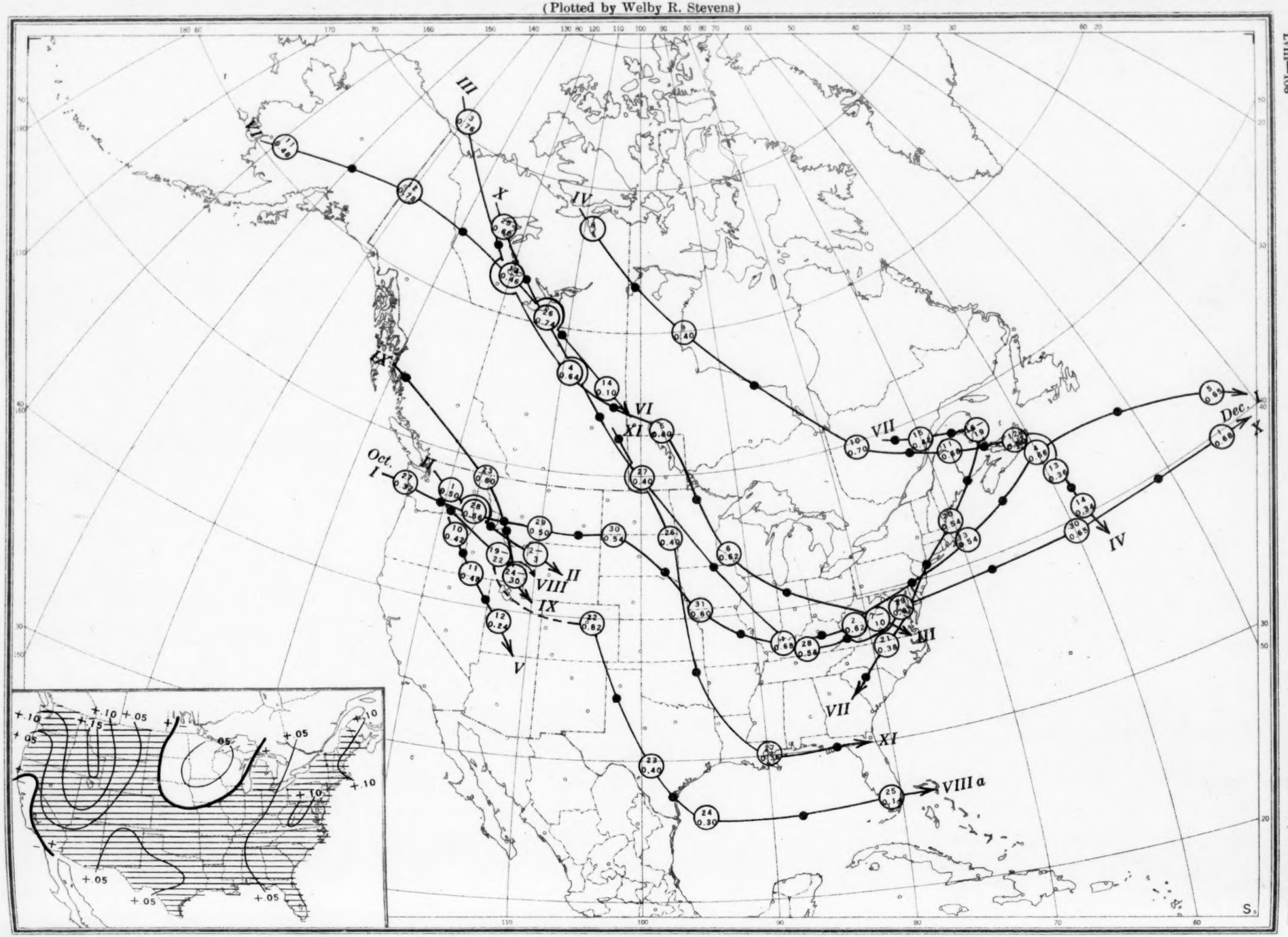

Shaded portions show excess (+).
Unshaded portions show deficiency (—).
Lines show amount of excess or deficiency.
Statute Miles
Kilometers

Chart II. Tracks of Centers of Anticyclones, November, 1930. (Inset) Departure of Monthly Mean Pressure from Normal

(Plotted by Welby R. Stevens)



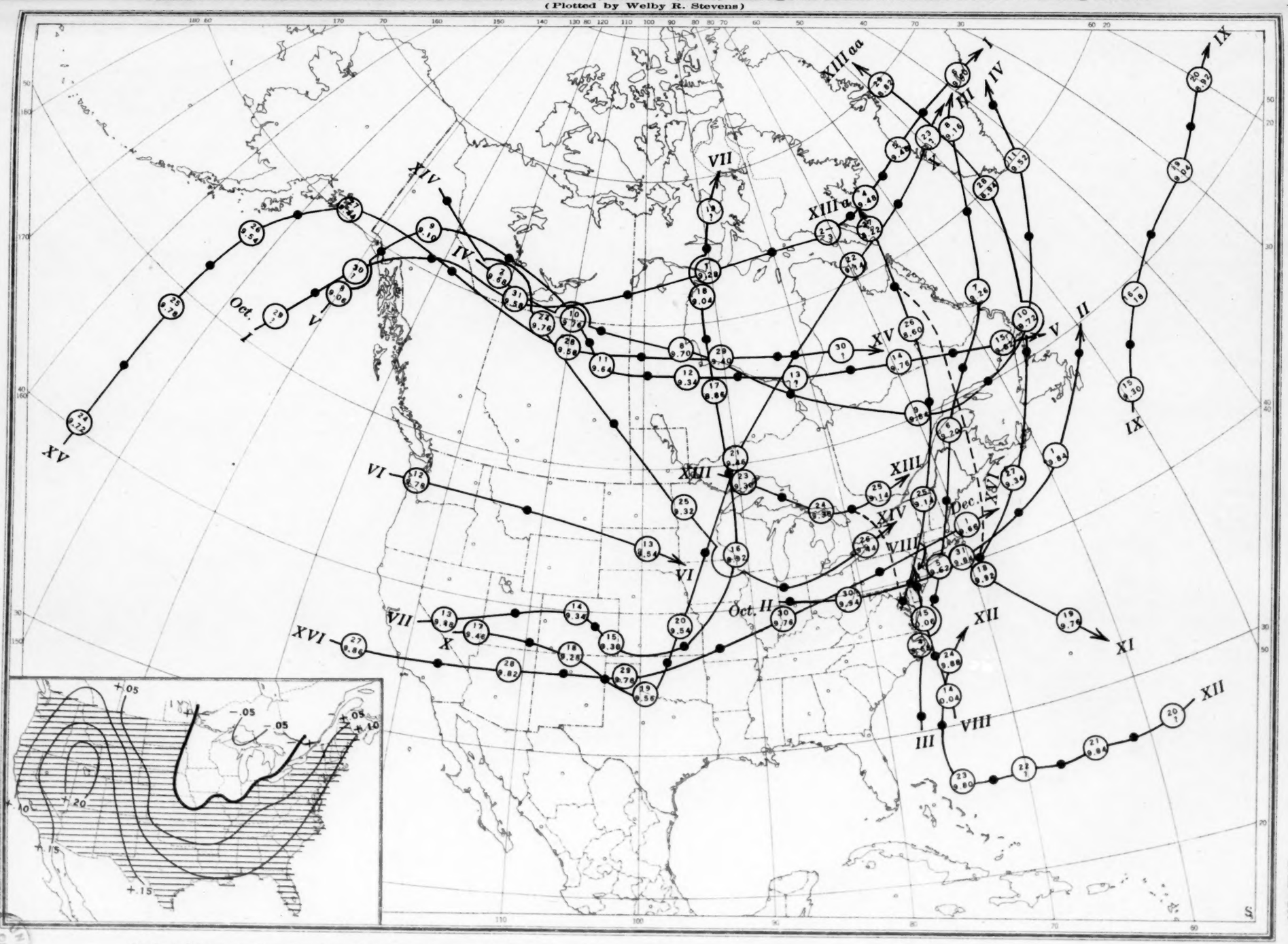
Circle indicates position of anticyclone at 8 a. m. (75th meridian time), with barometric reading. Dot indicates position of anticyclone at 8 p. m. (75th meridian time).

Chart III. Tracks of Centers of Cyclones, November, 1930. (Inset) Change in Mean Pressure from Preceding Month

(Plotted by Welby R. Stevens)

Circle indicates position of anticyclone at 8 a. m. (75th meridian time), with barometric reading. Dot indicates position of anticyclone at 8 p. m. (75th meridian time).

Chart III. Tracks of Centers of Cyclones, November, 1930. (Inset) Change in Mean Pressure from Preceding Month
(Plotted by Welby R. Stevens)



Circle indicates position of cyclone at 8 a. m. (75th meridian time), with barometric reading. Dot indicates position of cyclone at 8 p. m. (75th meridian time).

Chart IV. Percentage of Clear Sky between Sunrise and Sunset, November, 1930

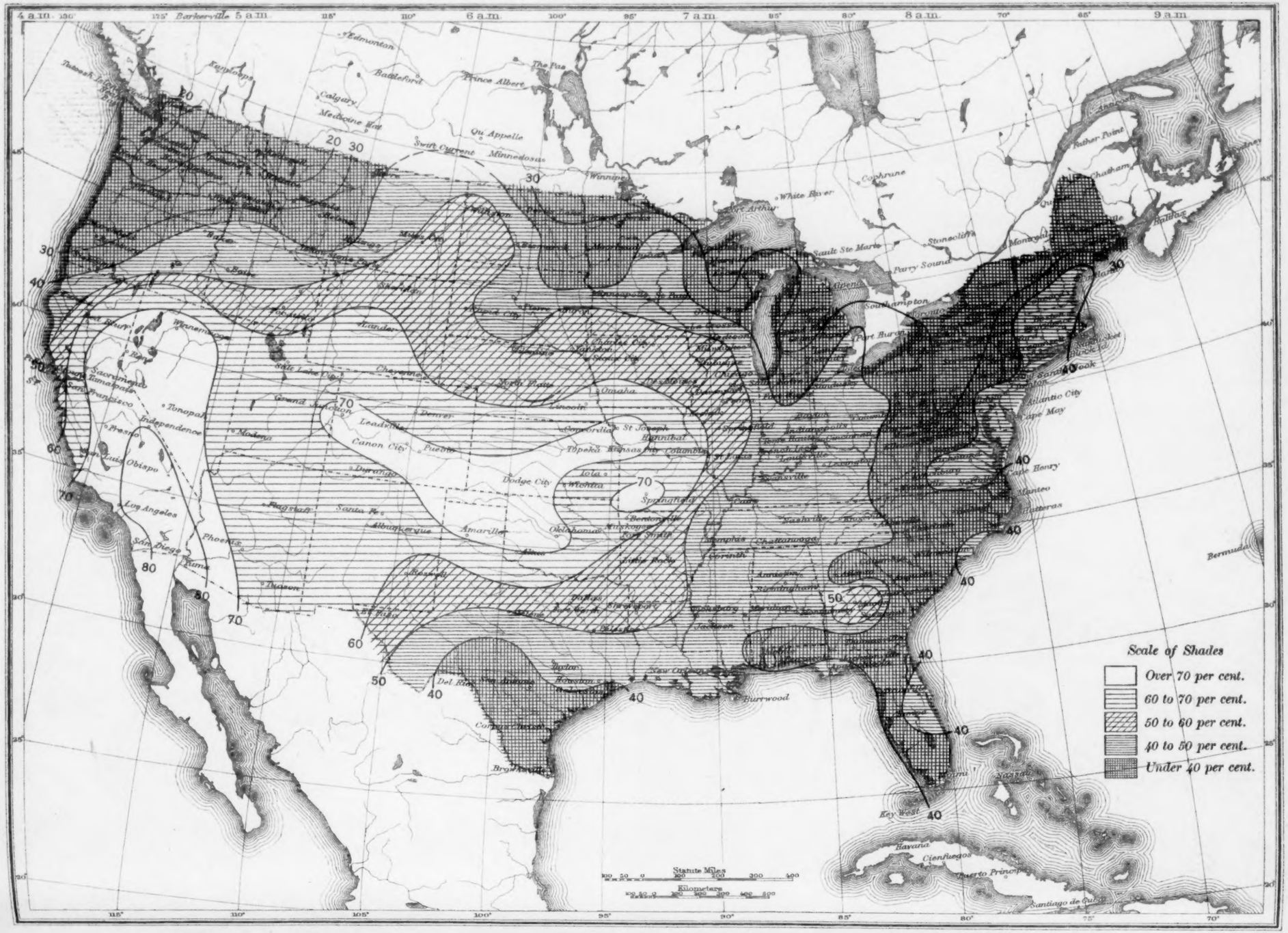


Chart V. Total Precipitation, Inches, November, 1930. (Inset) Departure of Precipitation from Normal

Chart V. Total Precipitation, Inches, November, 1930. (Inset) Departure of Precipitation from Normal

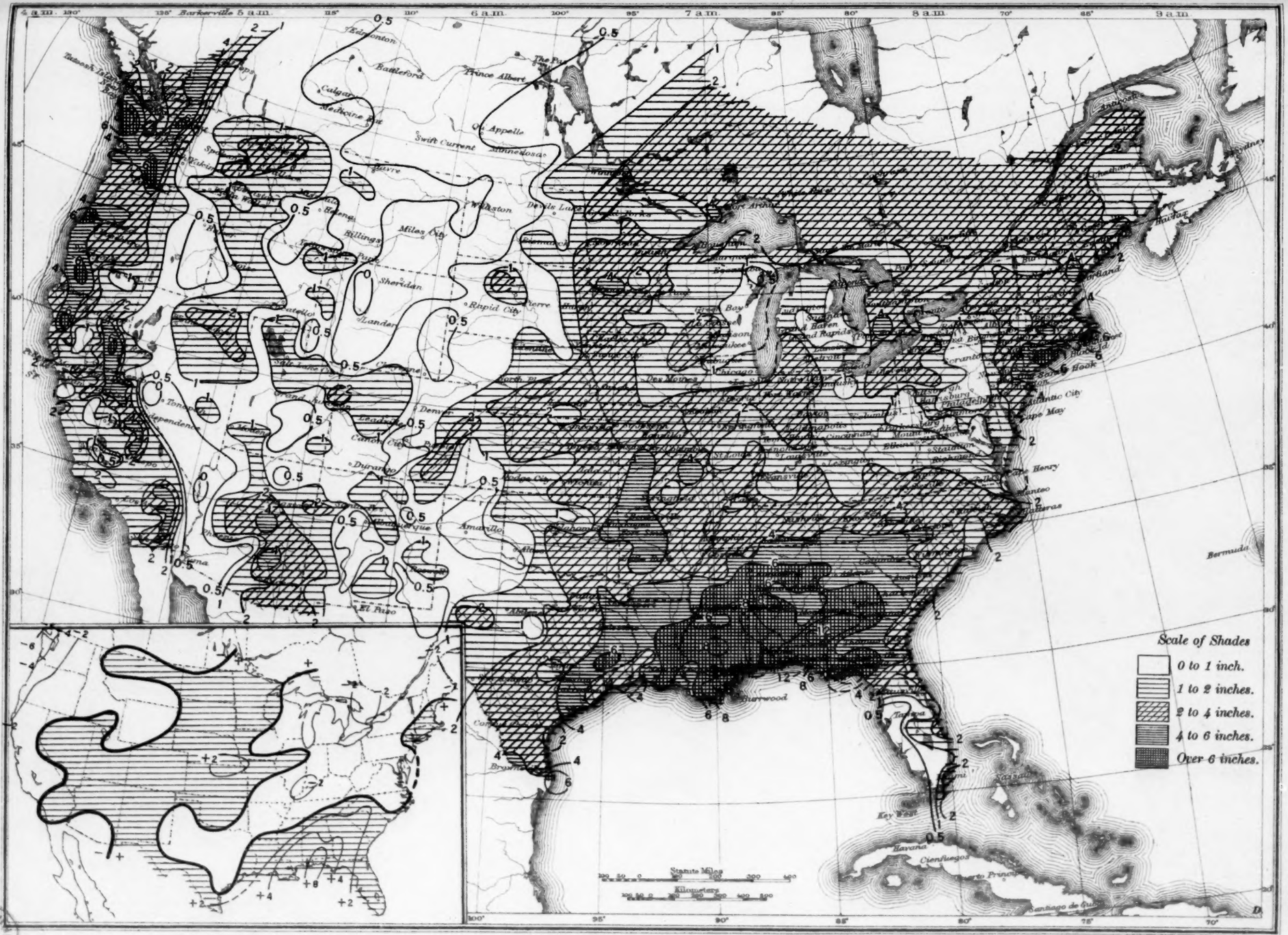


Chart VI. Isobars at Sea level and Isotherms at Surface; Prevailing Winds, November, 1930

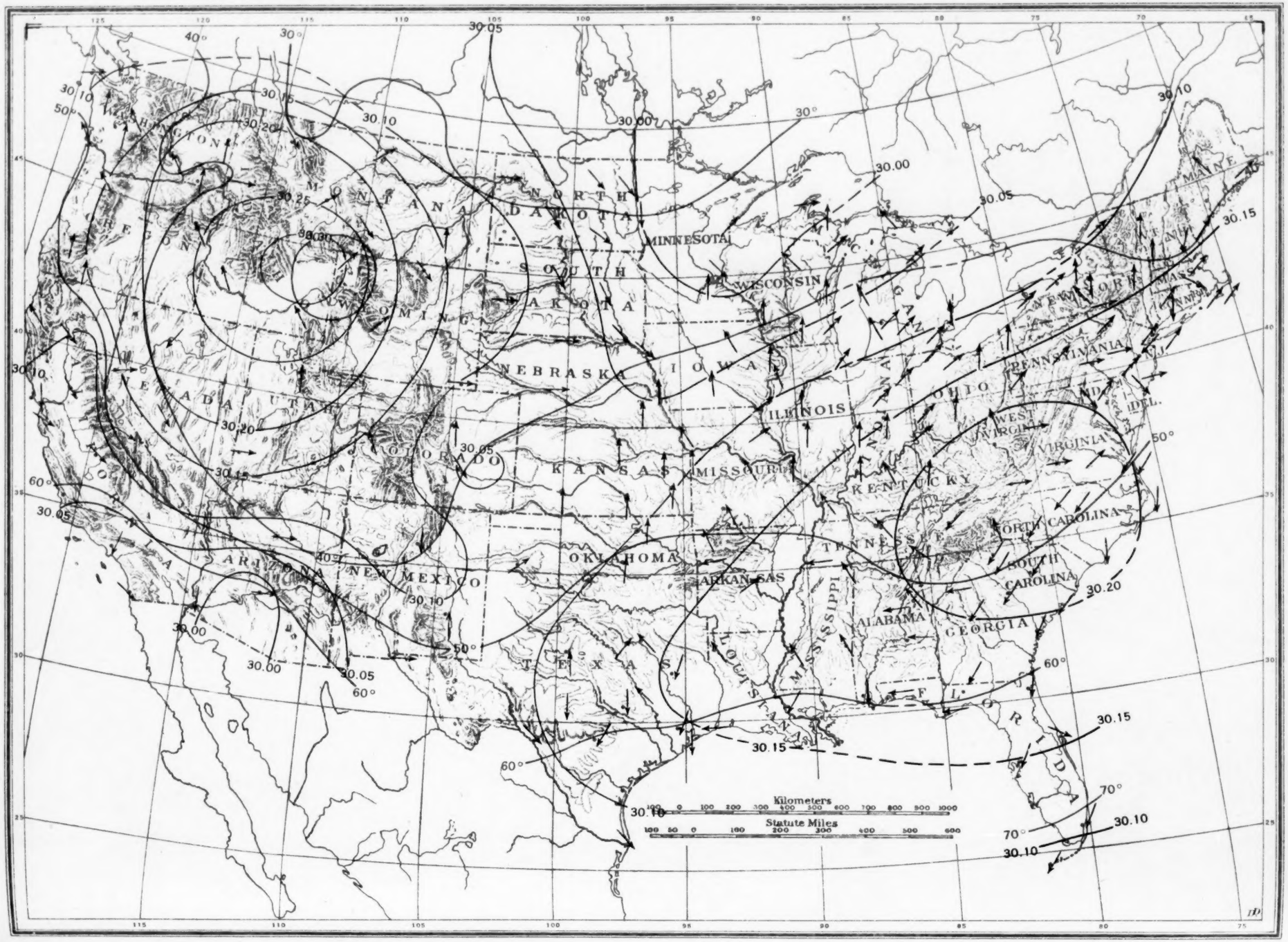


Chart VII. Total Snowfall, Inches, November, 1930. (Inset) Depth of Snow on Ground at end of Month

Chart VII. Total Snowfall, Inches, November, 1930. (Inset) Depth of Snow on Ground at end of Month

UNIV. OF MICH.

Chart VIII. Weather Map of North Atlantic Ocean, November 2, 1930
(Plotted by F. A. Young)

Chart VIII. Weather Map of North Atlantic Ocean, November 2, 1930
(Plotted by F. A. Young)

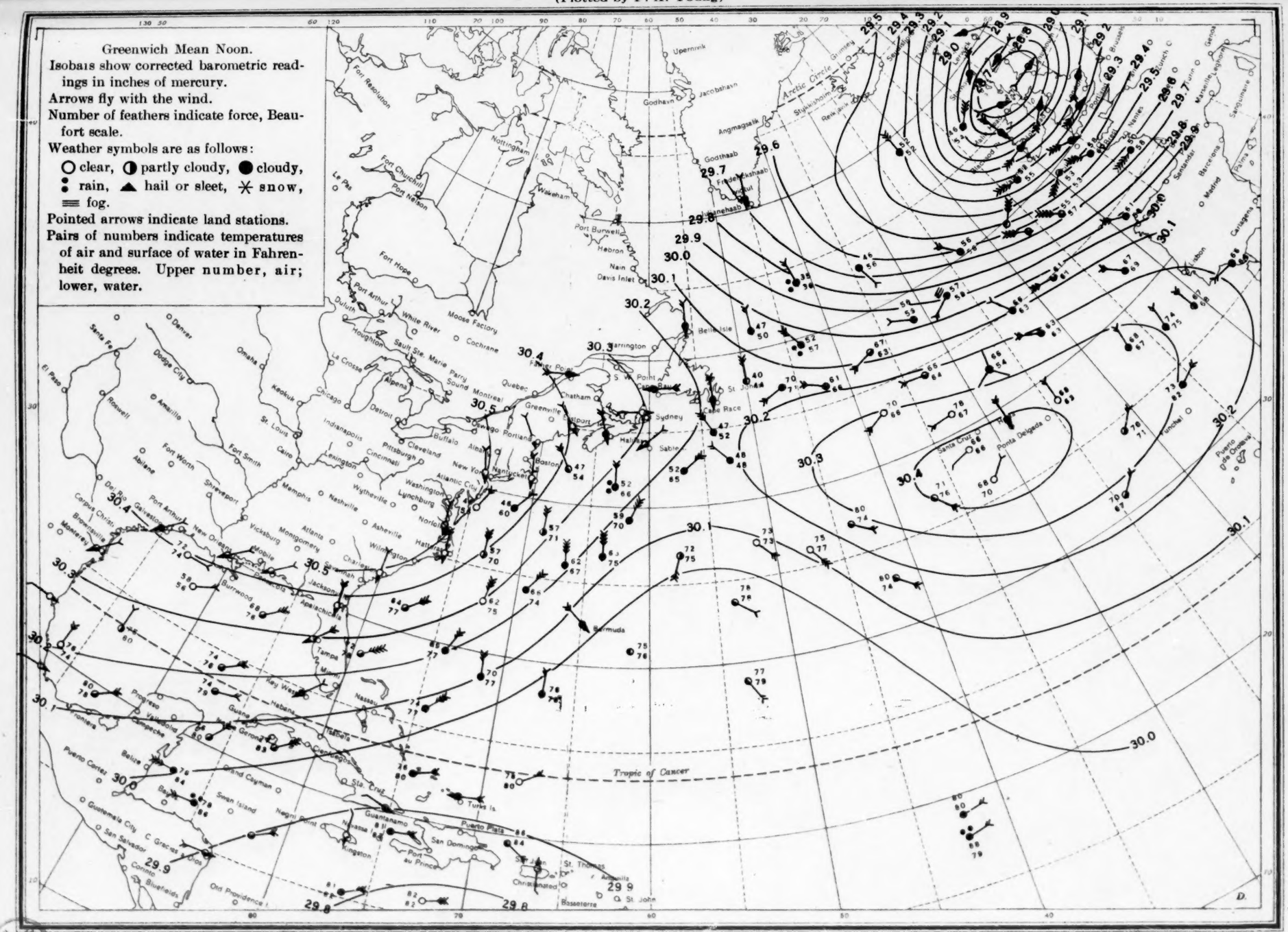


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Chart IX. Weather Map of North Atlantic Ocean, November 3, 1930

(Plotted by F. A. Young)

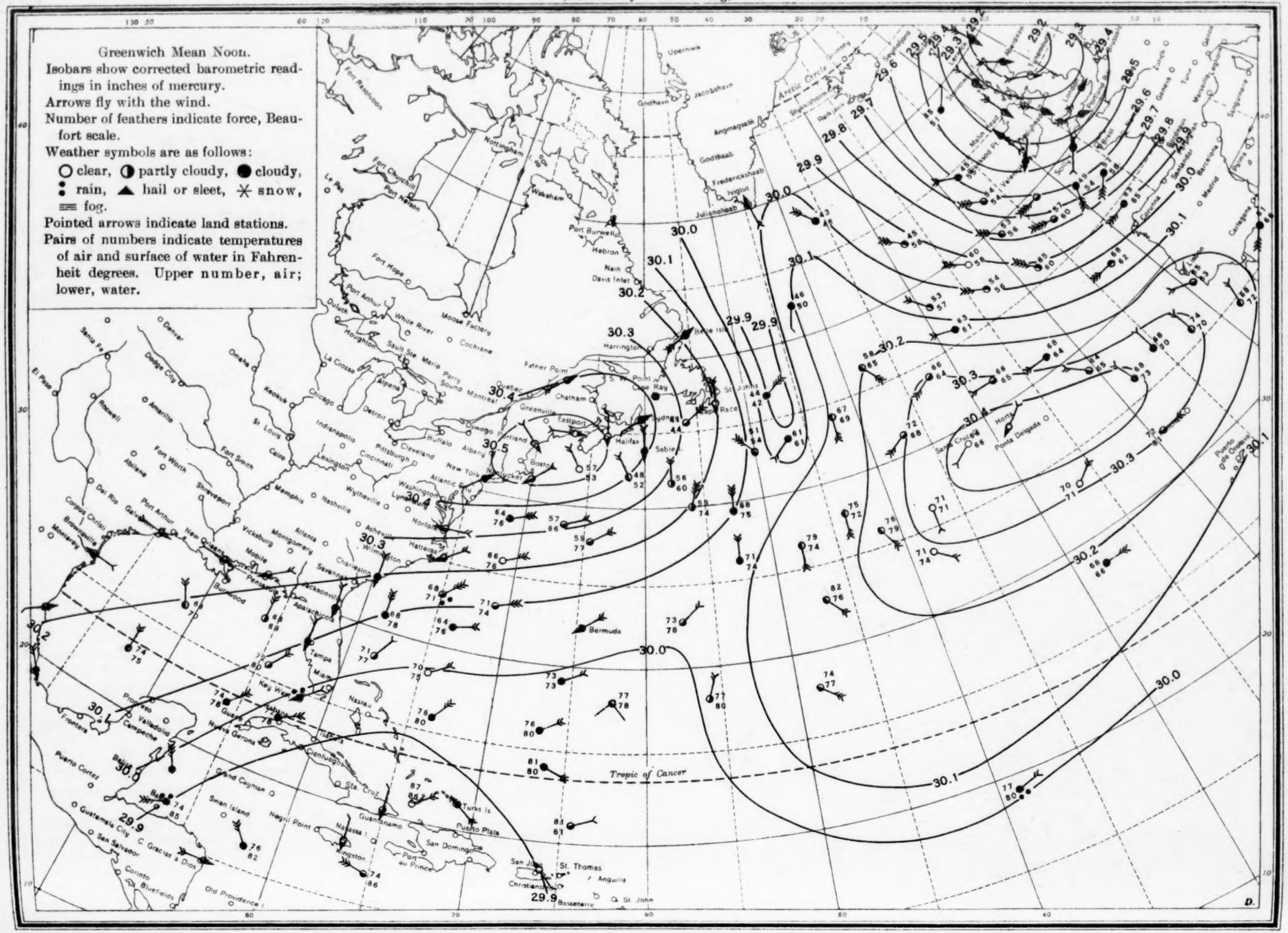
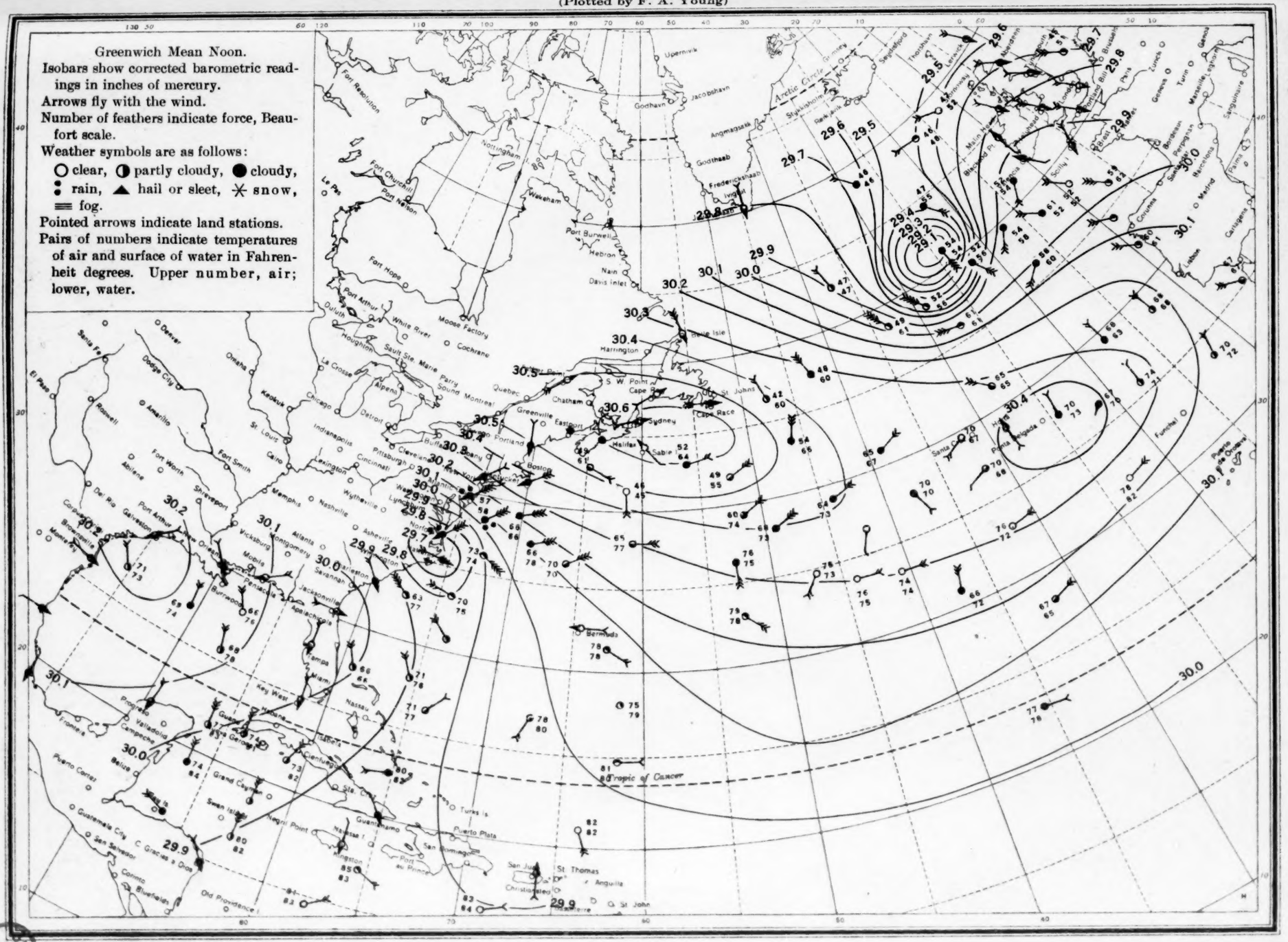

Greenwich Mean Noon.
Isobars show corrected barometric readings in inches of mercury.
Arrows fly with the wind.
Number of feathers indicate force, Beaufort scale.
Weather symbols are as follows:
clear, partly cloudy, cloudy, rain, hail or sleet, snow, fog.
Pointed arrows indicate land stations.
Pairs of numbers indicate temperatures of air and surface of water in Fahrenheit degrees. Upper number, air; lower, water.
Arctic Circle
Tropic of Cancer
D.

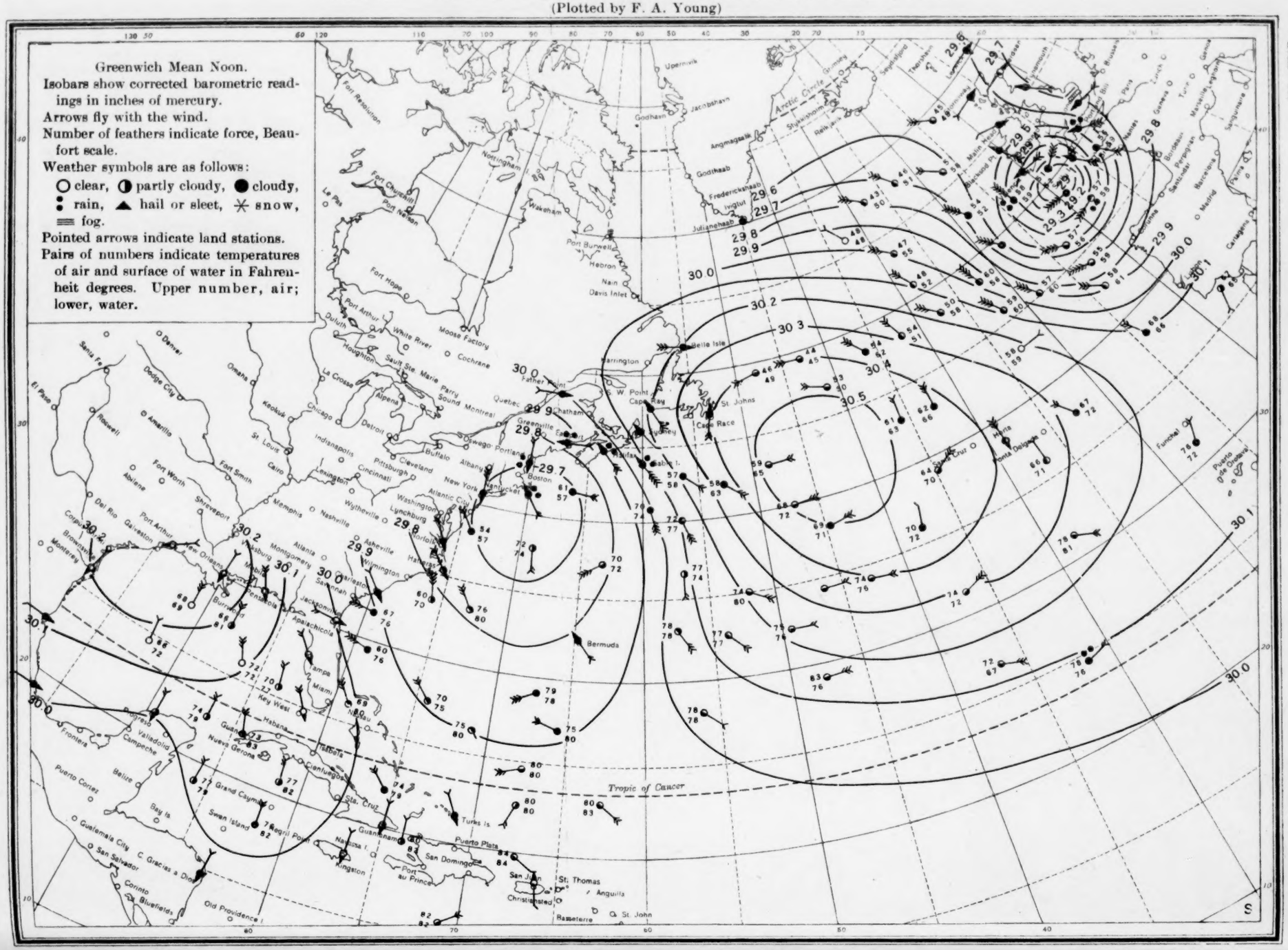
Chart X. Weather Map of North Atlantic Ocean, November 4, 1930

(Plotted by F. A. Young)

Chart X. Weather Map of North Atlantic Ocean, November 4, 1930
(Plotted by F. A. Young)


Greenwich Mean Noon.
Isobars show corrected barometric readings in inches of mercury.
Arrows fly with the wind.
Number of feathers indicate force, Beaufort scale.
Weather symbols are as follows:
clear, partly cloudy, cloudy, rain, hail or sleet, snow, fog.
Pointed arrows indicate land stations.
Pairs of numbers indicate temperatures of air and surface of water in Fahrenheit degrees. Upper number, air; lower, water.
Tropic of Cancer

UNIV. OF WICH.

Chart XI. Weather Map of North Atlantic Ocean, November 5, 1930

(Plotted by F. A. Young)